

# CALIFORNIA HYDROGEN INFRASTRUCTURE TOOL (CHIT) 2017 RELEASE WEBINAR: UPDATES AND NEW CAPABILITIES

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November 14, 2017

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# Discussion Outline

Purpose: To review updates made during 2015-2017 to the methodologies and data inputs provided with CHIT, the geographical information system tool developed by CARB to assist in analysis of needs for new hydrogen fueling infrastructure.

- Recap of CHIT fundamentals
- Simulated traffic intensity data
- Implementation of auto manufacturer survey and DMV registration data
- Alternative coverage gap formulation
- Coverage gap re-tuning tool
- Single station impact and re-evaluation tool
- Local capacity need calculation
- Evaluation grid geometry and coordinate system
- Demographic data updates and comparison to CVRP data
- Updated online map viewer
- Future implementation of CHIT

# Discussion Outline

- This discussion will answer questions like:
  - What new features and data inputs are available with CHIT 2017 Release?  
How were they developed?
  - What defaults settings have been adjusted in CHIT 2017 Release compared to 2015 Release?
  - What data inputs have been updated with CHIT 2017 Release?
  - What new operations are available with CHIT 2017 Release?
  - What is the current plan for ongoing CHIT development and use?

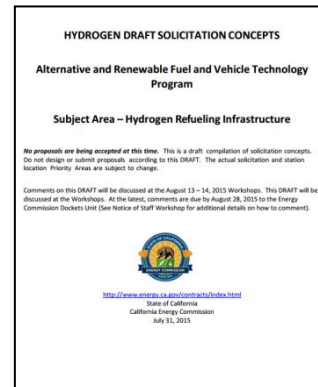
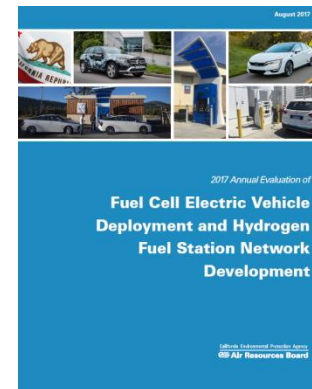
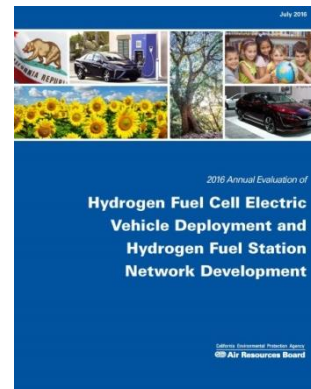
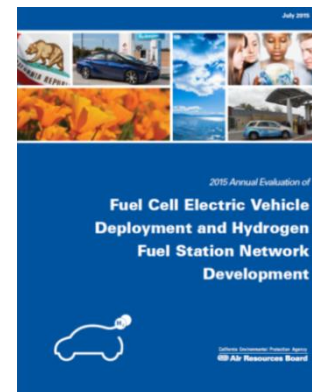
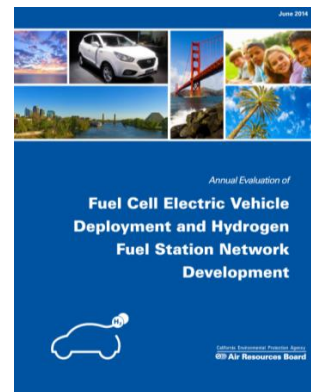
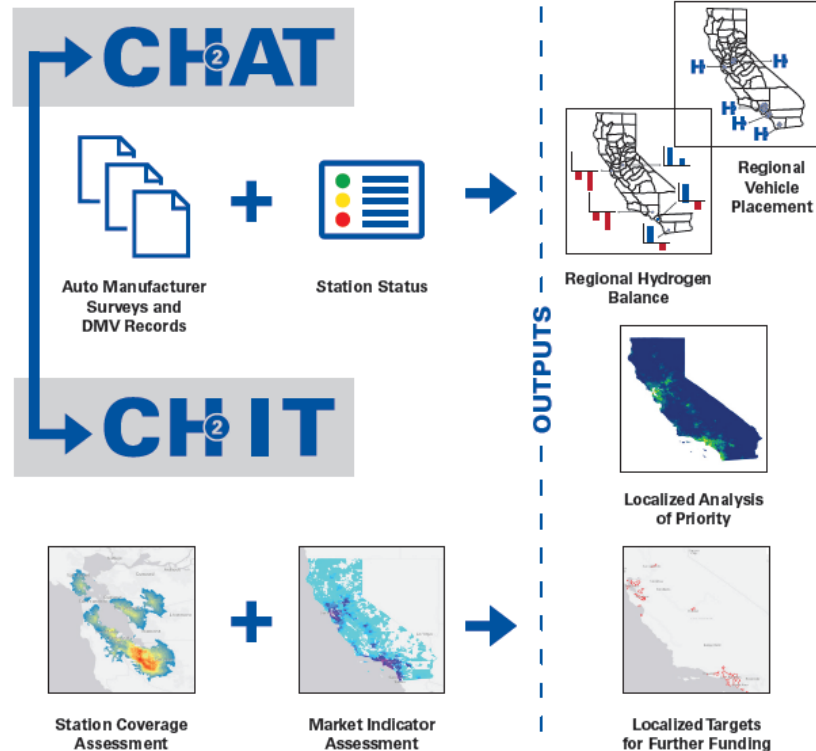
# REVIEW OF CHIT 2015 RELEASE

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# Review

## CHIT/CHAT Tools and AB 8

# CHIT CHAT

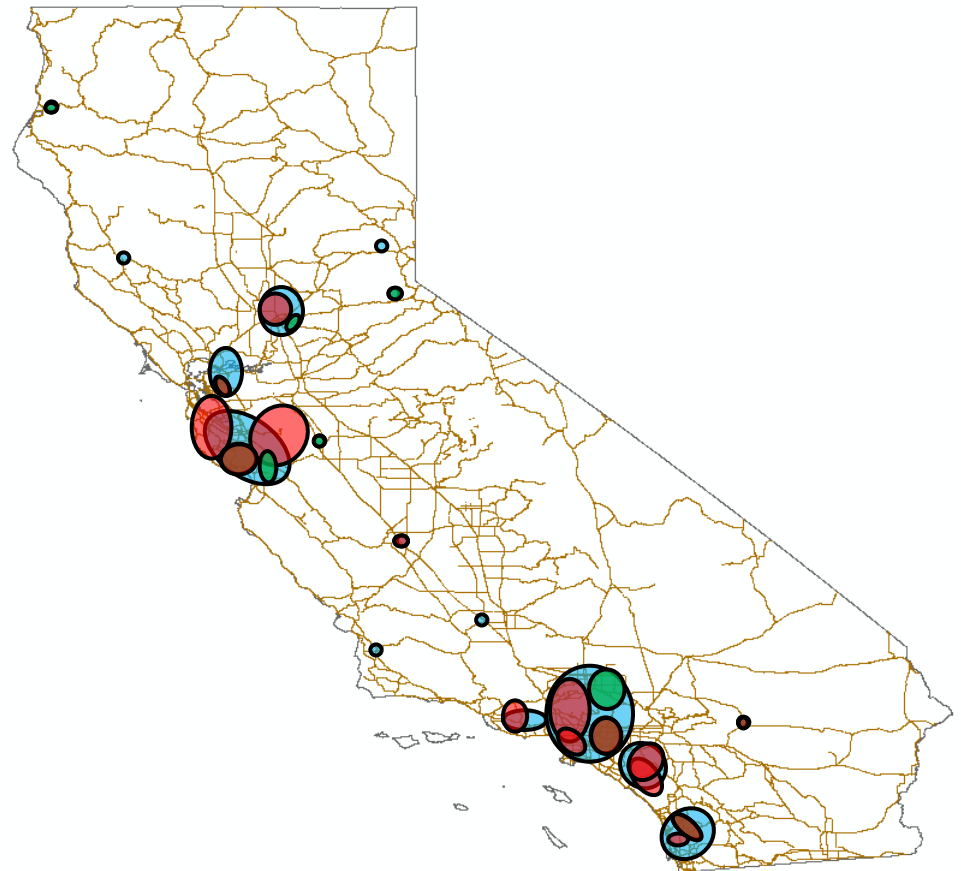


# Review

## Big Picture Goal

Plan infrastructure placement appropriately for upcoming FCEV releases

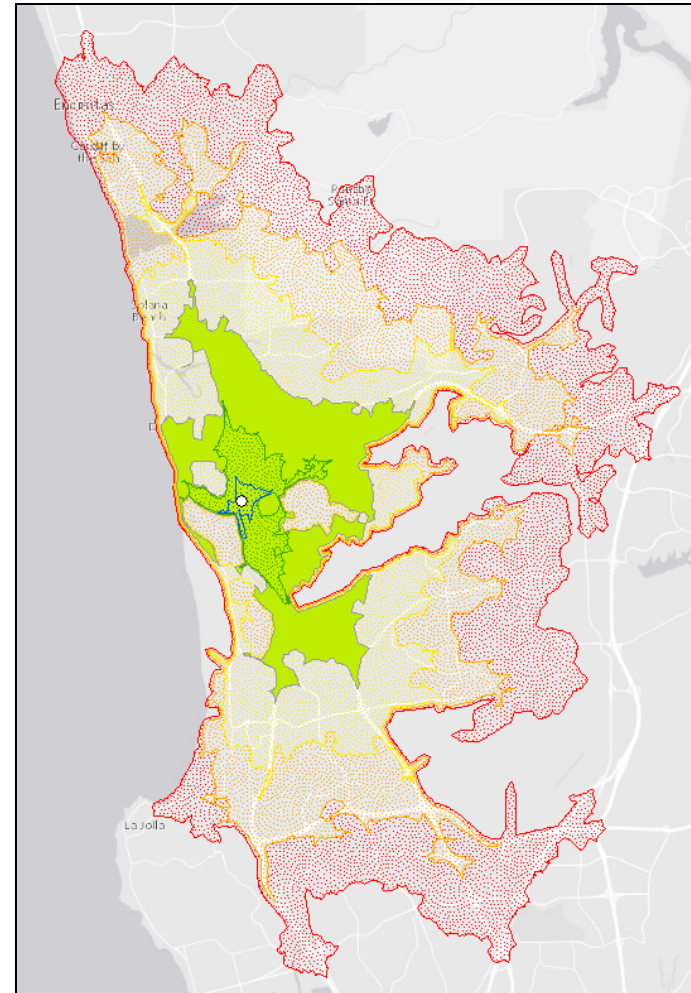
- 1) Identify Market
- 2) Evaluate current infrastructure  
Existing and potential station coverage
- 3) Prioritize uncovered market from  
year-to-year



# Review

## Central Theme: Coverage

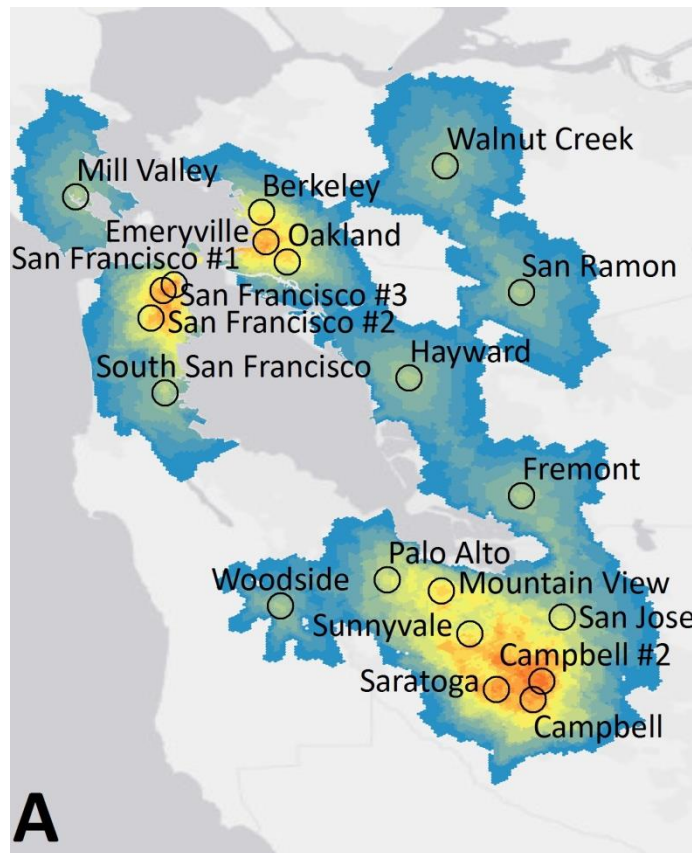
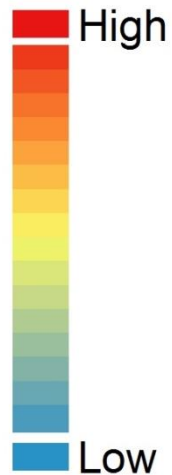
- Conceptual representation of convenient access to fueling stations
- Often discussed in terms of drive time, e.g. coverage is provided to all neighborhoods within a 15-minute drive of a station
- Coverage can be conceptualized as binary (yes/no) or as degrees of coverage
- Well-planned coverage increases consumer confidence and adoption of vehicles



# Review

## Goals for Analyzing Existing Coverage

### Relative Coverage



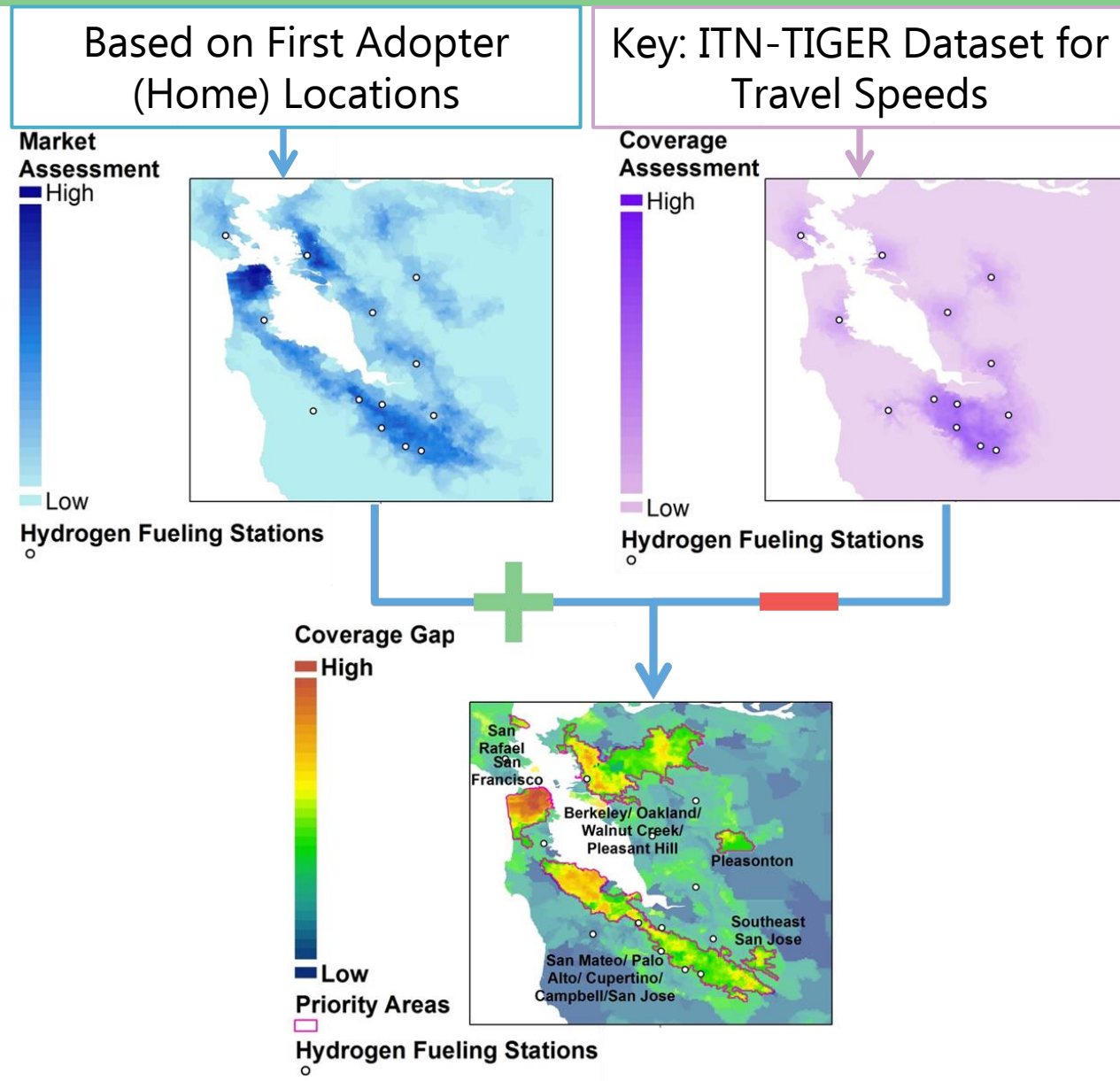
\*Areas without coverage have no color and score highest

- Provides an estimate of coverage that is more informative than a binary yes/no, allowing for estimation of degrees of coverage
- Estimates combined coverage provided by multiple stations that may be reachable within various drive times



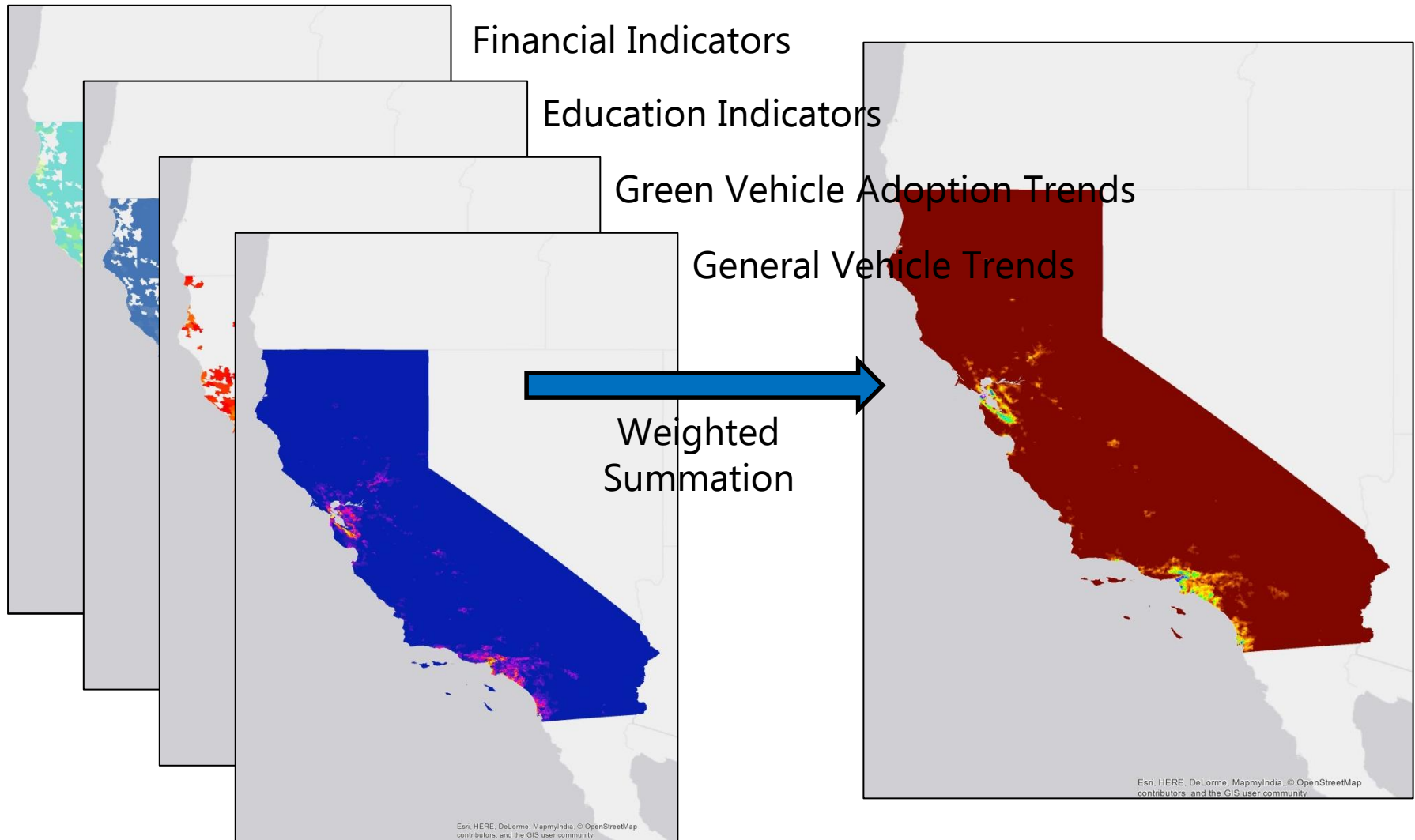
# Review

- CHIT is a planning tool intended to provide general direction indicating areas of needed infrastructure
- CHIT evaluates relative need for hydrogen infrastructure based on a gap analysis between a projected market and current infrastructure



# Review

## Analyzing the Early Adopter Market



# Review

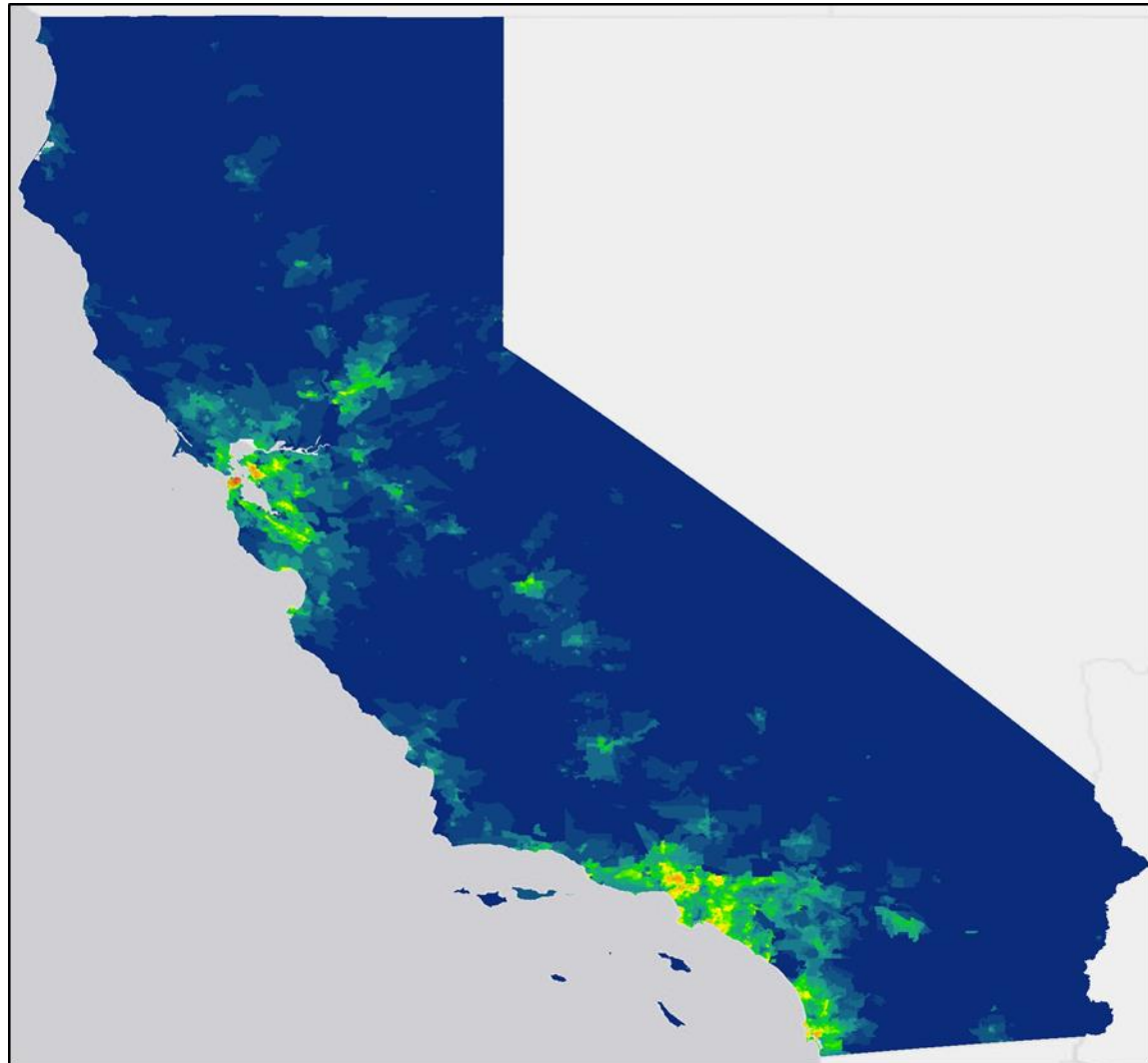
## Coverage Gap Map Formulation

$$\text{Heat} = \text{Coverage} * \text{Market}$$

$$\text{Coverage} = 0.5 * \text{Existing} + 0.5 * \text{Potential}$$

$$\text{Market} = 0.5 * \text{Financial} + 0.3 * \text{P/HEV} + 0.2 * \text{Edu}$$

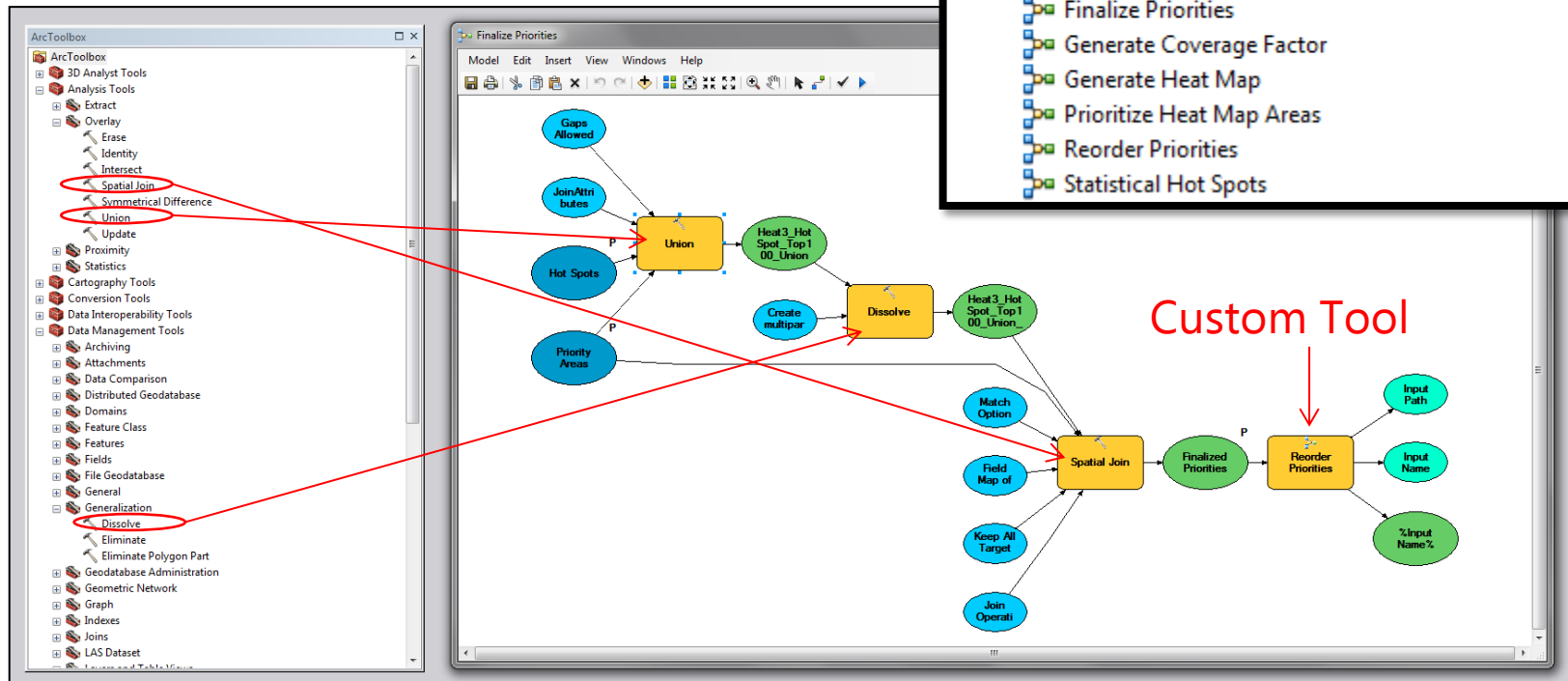
$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \text{MSRP} + 0.33 * \text{Luxury}$$



# Review

## CHIT 2015 Toolbox

- CHIT is (mostly) a set of custom tools built in ArcGIS ModelBuilder
- Some iterative
- Some nested
- Lots of Spatial Analysis



# Guiding Principles

CHIT is envisioned as a tool that could be used year-after-year for public planning and reporting purposes, while providing a consistent assessment method across the entire state. Related fundamental principles guide development of CHIT:

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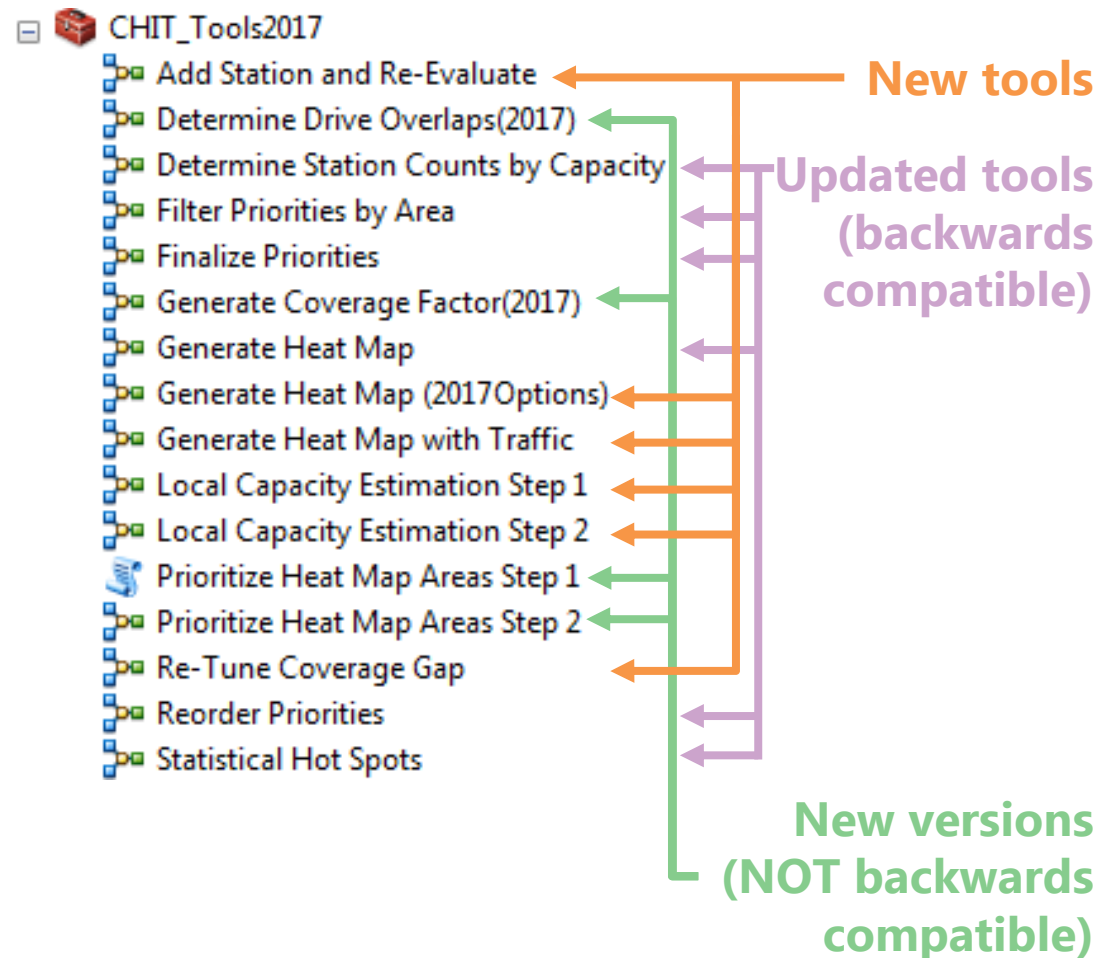
- Principle #1: CHIT is a relative assessment
- Principle #2: CHIT is a statewide assessment
- Principle #3: CHIT assesses only the first adopter market
- Principle #4: The FCEV market can be estimated by the relative distribution of multiple demographic indicators
- Principle #5: Accurate assessment of coverage depends on detailed roadway data
- Principle #6: Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes
- Principle #7: CHIT must be a tool that can be shared with the public

# CHIT 2017 TOOLBOX OVERVIEW

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# CHIT 2017 Toolbox

- Prior unreleased tools
- New tools developed for GFO-15-605 support
- New tools developed based on stakeholder feedback
- New tools developed for 2017 Annual Evaluation
- Process improvements



# CHIT 2017 Toolbox

**Generate Heat Map (2017Options)**

Click error and warning icons for more information

CA\_HexCells  
C:\CHIT\CHIT2017.gdb\CA\_HexCells

Traffic Volume Map  
C:\CHIT\CHIT2017.gdb\Traffic\_Intensity2017

Traffic Volume Weight  
0.2

Access Factor Map  
C:\CHIT\CHIT2017.gdb\Access\_Factor2017

Access Weight  
0.1

Coverage Factor Map  
C:\CHIT\CHIT2017.gdb\DriveRatings\_2017

No Coverage Value  
2

Financial Weight  
0.5

Income Factor Map  
C:\CHIT\CHIT2017.gdb\Income\_Factor2017

Income Weight  
0.34

Luxury Vehicle Factor Map  
C:\CHIT\CHIT2017.gdb\Luxury\_Veh2017

Luxury Vehicle Weight  
0.33

MSRP Factor Map  
C:\CHIT\CHIT2017.gdb\MSRP\_Veh2017

MSRP Weight  
0.33

Education Factor Map  
C:\CHIT\CHIT2017.gdb\Education\_Factor2017

Education Weight  
0.2

Green Vehicle Market Map  
C:\CHIT\CHIT2017.gdb\HEV\_PHEV2017

Green Vehicle Weight  
0.3

Auto Manufacturer Splits  
C:\CHIT\CHIT2017.gdb\County\_Survey

FCEV Registrations  
C:\CHIT\CHIT2017.gdb\ZIP\_FCEV\_Regs

Registered FCEV Weight  
0.1

Heat Map  
C:\CHIT\CHIT2017.gdb\Coverage\_Gap2017

☐ Include OEM Survey Weighting

**Generate Heat Map (2017Options)**

Generates a statewide heat map of localized desirability/need for new hydrogen refueling station (s). The output feature class will have geometry matching the selected input grid file.

Key features new to CHIT 2017 Release:

- ARB's implementation uses a hexagonal grid, replacing the previous square grid
- The option to include traffic intensity data as a market input
- The option to include auto manufacturer survey responses as a market input
- The option to include registered FCEV data as a market input

The input maps may be of any arbitrary polygon geometry. However, they each have a requirement for a specific field name denoting the local score of that factor. The user is highly advised to review the input file requirements listed in this tool's help while implementing the tool.

The final heat map score will be stored in the output feature class in a field called HeatScore\_CxM.

Algebraically, the heat map is represented by the following set of equations:

$$\text{HeatScore} = \text{CoverageScore} * (x * \text{Market Score} + y * \text{Drive Volume Score})$$

$$\text{CoverageScore} = a * \text{Existing Coverage} + b * \text{Potential Access}$$

$$\text{MarketScore} = ((1 - w) * (c * \text{Financial} + d * \text{PHEV and HEV} + e * \text{Education}) + w * \text{Registrations}) * \text{Auto Manufacturer Response}$$

$$\text{Financial} = f * \text{Income} + g * \text{Luxury Vehicles} + h * \text{Vehicle MSRP}$$

Coefficients a through h, and w through y are weighting factors, as described in the explanations for each parameter. The following rules should be followed for weighting factors:

$x + y = 1$  (in CHIT 2017 this is enforced automatically)

$a + b = 1$  (in CHIT 2017 this is enforced automatically)

OK Cancel Environments... << Hide Help Tool Help

Updated base input data

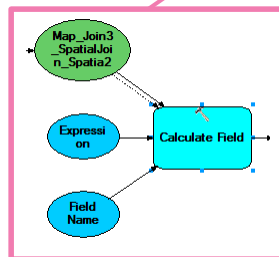
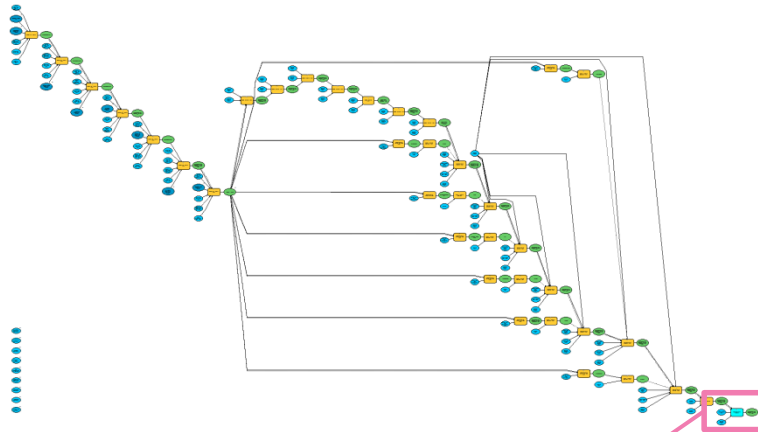
New functionality options in some tools (See Users Guide v2 for guidance on invoking new features)

New input data options available in some tools



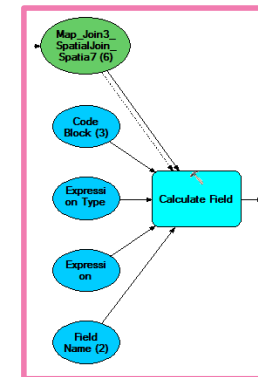
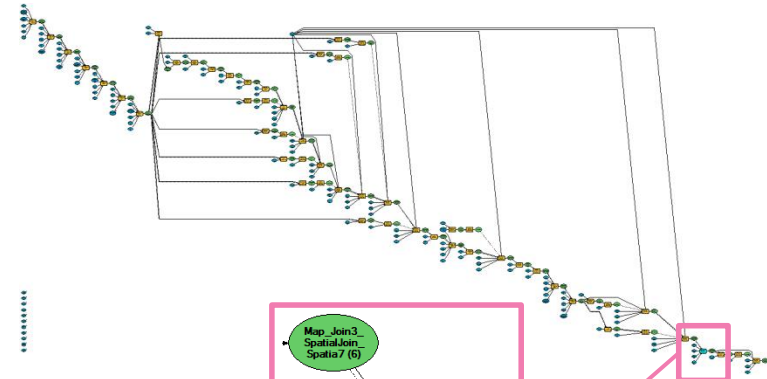
# CHIT 2017 Toolbox

## CHIT 2015 Release



(%Coverage Weight%\* [Rel\_Score\_DT] +%Access Weight%\*  
[Rel\_Score\_AC])\*(%Financial Weight%\*(%Luxury Vehicle Weight%\*  
[Rel\_Score\_LV] +%Income Weight%\* [Rel\_Score\_Inc]+%MSRP Weight%\*  
[Rel\_Score\_MSRP])+%Education Weight%\* [Rel\_Score\_Ed]+%Green Vehicle  
Weight%\* [Rel\_Score\_GV] )

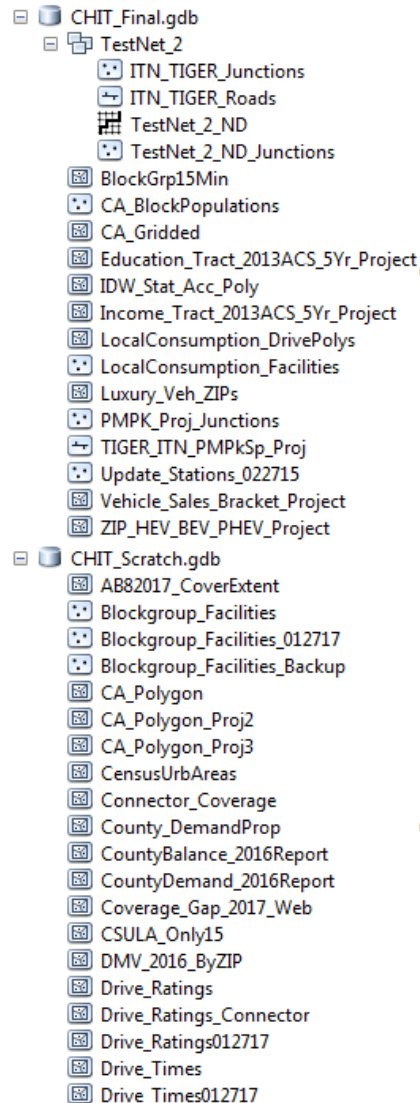
## CHIT 2017 Release



```
def
calcgap(b,Cov,Acc,q,x,w,Lux,u,Inc,v,MSRP,z,Ed,y,GV,Vol,t,Reg,OEM,OEMswitch):
  Financial= u*Inc + v*MSRP + w*Lux
  if b == 0:
    Coverage= Cov
  else:
    Coverage= (1.0-b)*Cov+b*Acc
  if OEMswitch:
    Market= ((x*Financial + y*GV+z*Ed)*(1.0-t)+t*Reg)*(OEM+0.1)
  else:
    Market=(x*Financial+y*GV+z*Ed)*(1.0-t)+t*Reg
  if b == 0:
    Market = Market * Acc
  CovGap= Coverage*((1.0-q)*Market+q*Vol)
  return CovGap
```

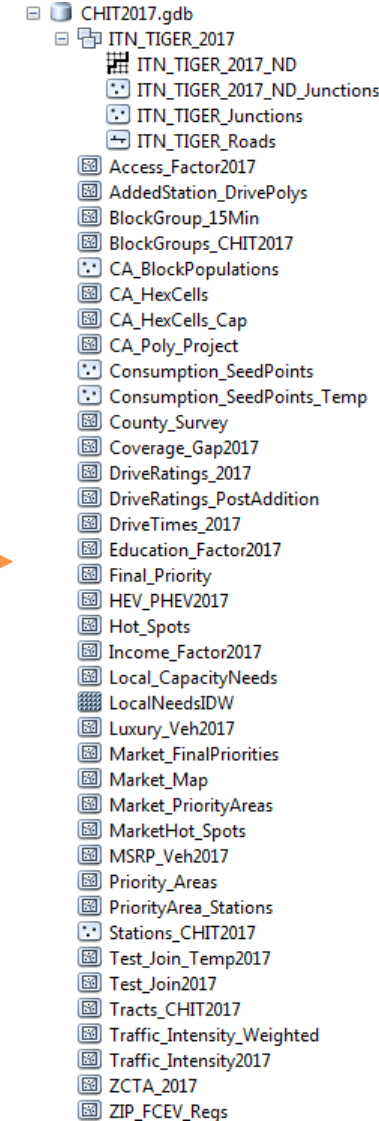
# CHIT 2017 Toolbox

## CHIT 2015 Release



- Consolidate 2 gdb's to 1
- Add new data layers
- Simplified Naming

## CHIT 2017 Release



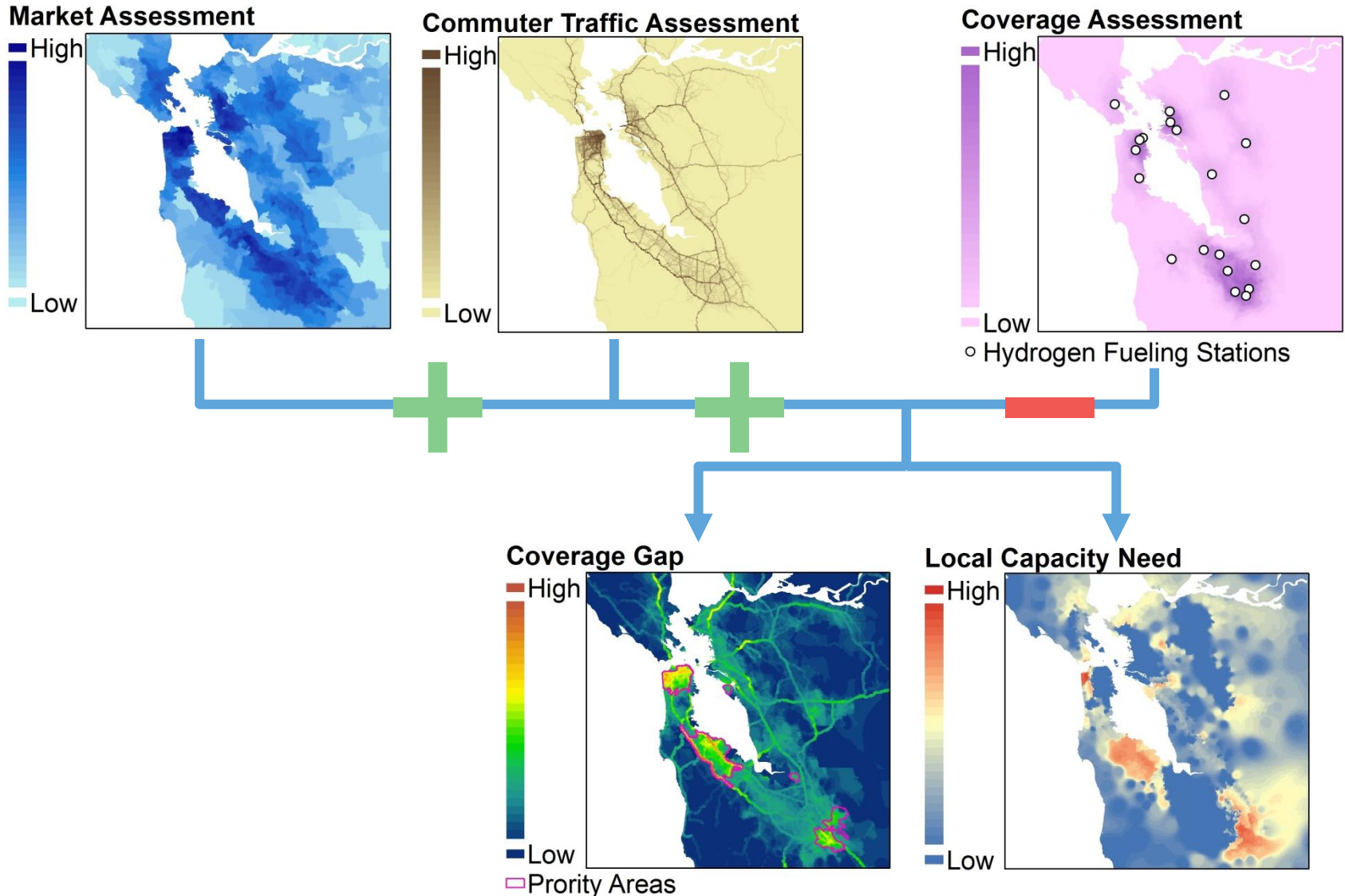
# SIMULATED TRAFFIC INTENSITY

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# Traffic Intensity Changes CHIT Fundamentals

- Principle #6 (2015): Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes
- **Principle #6 (2017): Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes and/or within proximity to commonly-traveled routes**
- Principle #4 (2015): Identification of the FCEV market can be estimated by consideration of the relative distribution of multiple demographic indicators
- **Principle #4 (2017): Identification of the FCEV owner market can be estimated by consideration of the relative distribution of multiple demographic indicators; the total fueling market potential can be estimated by consideration of both the owner market and commonly-traveled routes**

# CHIT 2017 Release Structure Revised

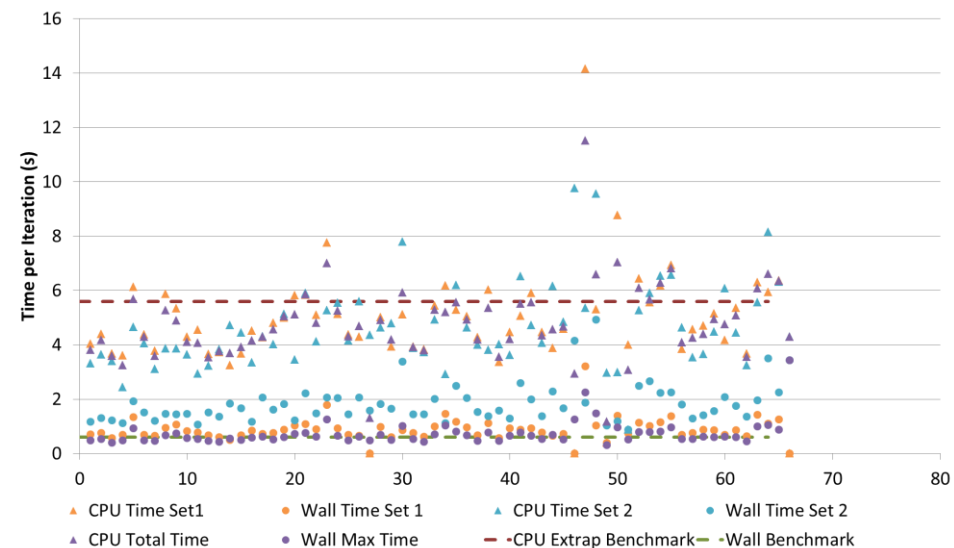
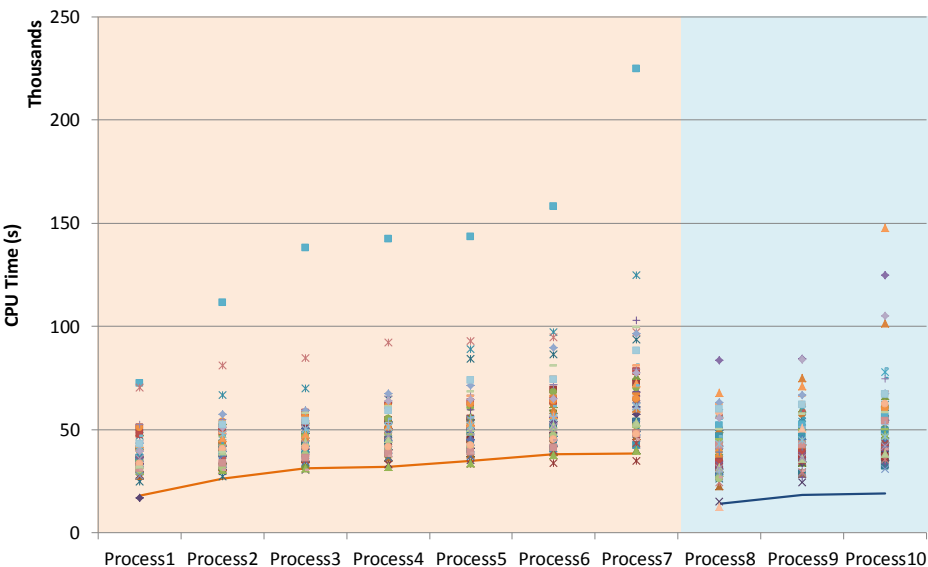


# Simulation Concept

- Given a sufficiently-detailed street geometry and travel speed data (provided by ITN-TIGER)...
- Availability of Origin-Destination data for commutes may enable route simulation...
- However, simulated data requires elevated scrutiny compared to observational data
- Major lead: Stakeholder suggestion at October 2015 webinar to look into LODES (LEHD Origin-Destination Employment Statistics) data set

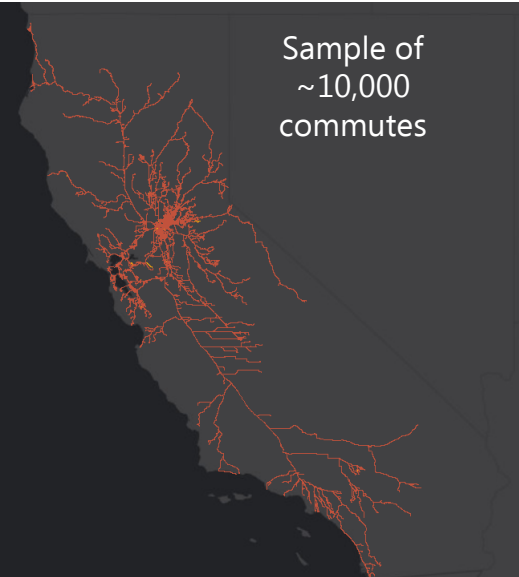
# Method

- Step 1: Simulate all entries in the LODES data file
  - Geocode census block centroids and extract x/y to be able to load origins and destinations in Network Analyst
  - Use Network Analyst to simulate PM commute routes of all entries
    - Inherently assumes travel time optimization
  - Large processing effort: ~7.6 million records for ~8.36 million commutes
  - Executed via stand-alone arcpy across 10 processors on 2 computers
  - Batch processed 10,000 routes on each processor at a time: ~6 months

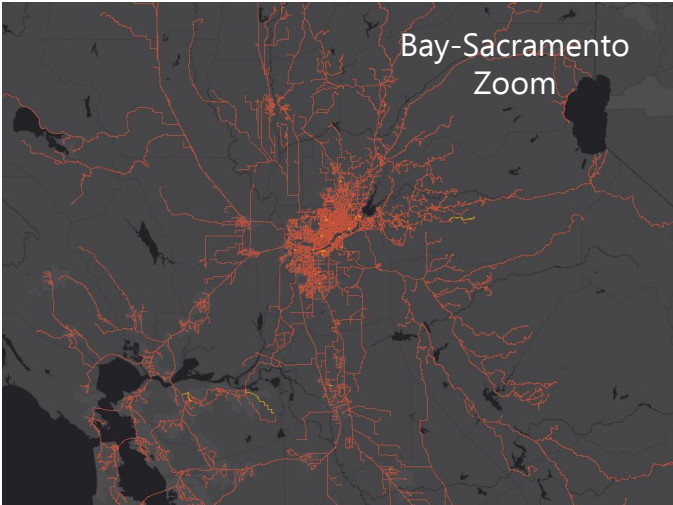


# Method

- Step 2: Combine data from resulting ~760 files
  - Down-select within each file to routes with 2 hours or less drive time
  - Spatially join with analysis grid
  - Keep running total of number of commutes through each cell
  - Smaller computing effort: python script executed in ArcMap
  - Batch processed over ~3 weeks



Sample of  
~10,000  
commutes



Bay-Sacramento  
Zoom



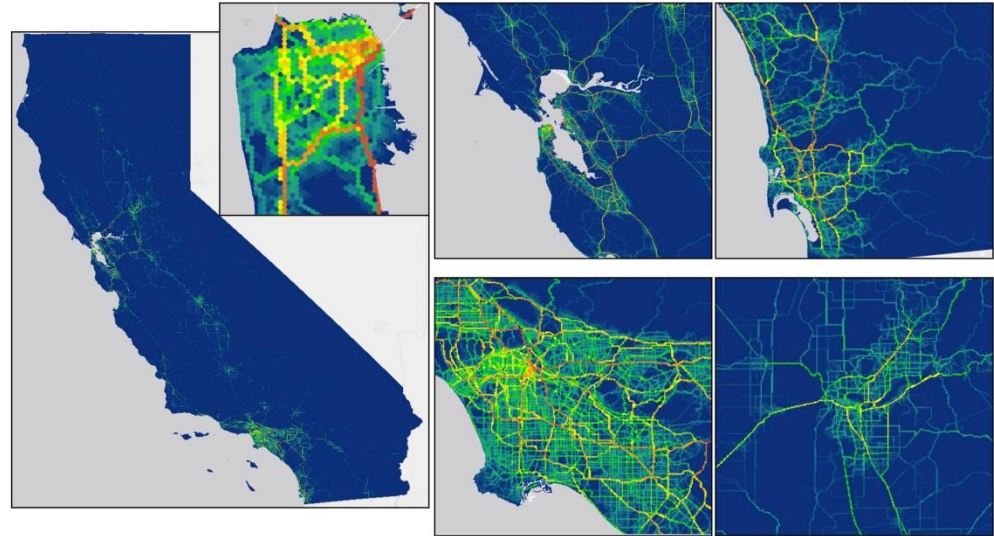
Subset of  
commutes  $\leq$  2  
hours



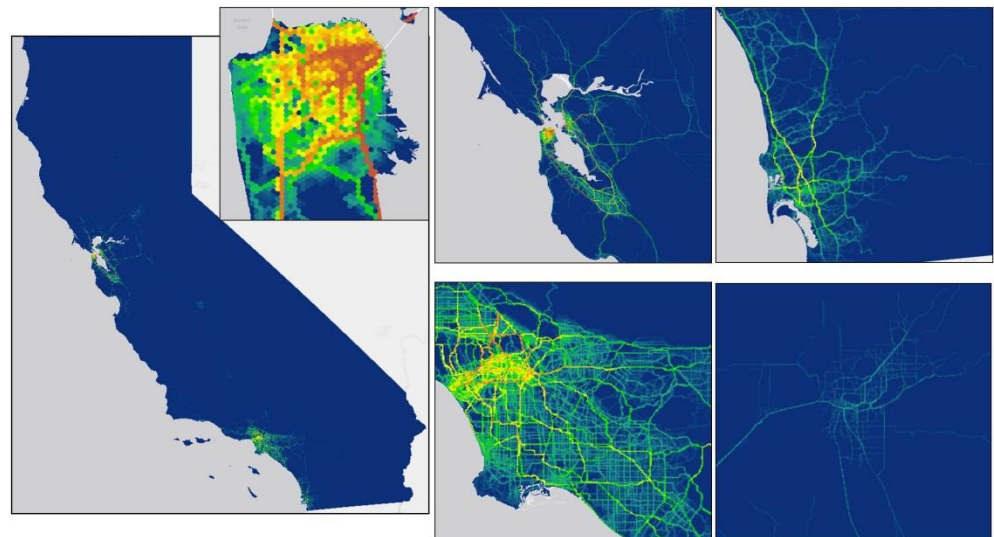
# Method

- Step 2, adjusted:  
Combine data and weight each drive according to home-based market potential
  - Concept was suggested at March webinar and received positive stakeholder feedback
  - Allows traffic data to more selectively reflect FCEV first adopters' likely driving patterns
  - Due to time constraints, uses 2015 market assessment
  - Both data sets available in CHIT 2017 for user implementation

Unweighted  
Traffic Data



Weighted  
Traffic Data



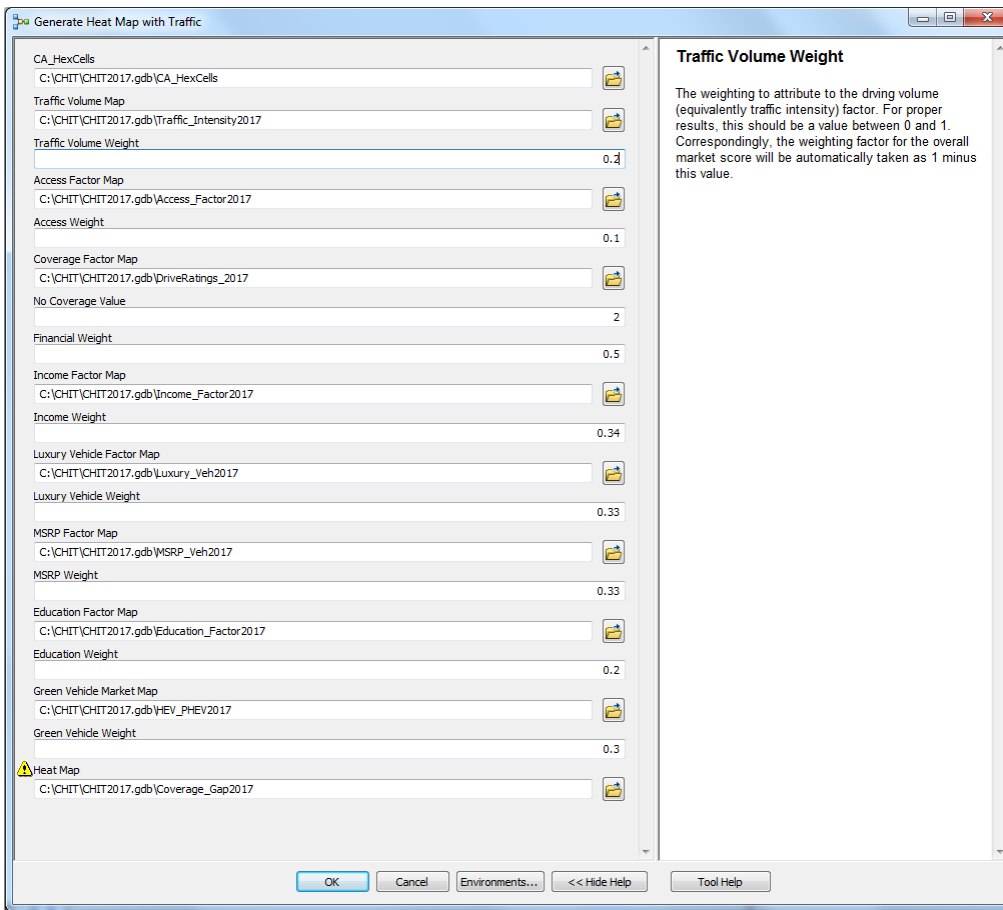
# Recap of Simulated Data Set

- What the simulated traffic data **DOES** provide:
  - Detailed routing information, based on speed data at fine resolution
  - The optimized travel route for the simulated commuters, given the input speed data
  - A reasonably-sized sample of the full labor force
    - US Bureau of Labor Statistics estimates ~17.6 million in California's employed work force in late 2014
  - An estimate of what the relative commuter traffic intensity might be in different locations throughout the state
  - A unified estimate that is similarly developed for all locations in the state
  - An estimate of traffic volume that is self-consistent with traffic speeds already implemented in CHIT

# Recap of Simulated Data Set

- What the simulated traffic data **DOES NOT** provide:
  - Observed, actual routes of commuters
  - The full commuter travel pattern
  - Travel patterns of non-commuter vehicles
    - Occupational, Medium-Duty, Heavy-Duty, and other vehicles not included
    - The traffic patterns of these vehicles can affect Light-Duty commuter traffic
    - The intricacies and interactions are not accounted for
  - An assessment of commuter travel via public transportation or other modes
  - Any indication of the travel routes specifically utilized by first adopters
  - Exact door-to-door routes

# Using Traffic Data



- CHIT\_Tools2017
  - Add Station and Re-Evaluate
  - Determine Drive Overlaps(2017)
  - Determine Station Counts by Capacity
  - Filter Priorities by Area
  - Finalize Priorities
  - Generate Coverage Factor(2017)
  - Generate Heat Map
  - Generate Heat Map (2017Options)**
  - Generate Heat Map with Traffic**
  - Local Capacity Estimation Step 1
  - Local Capacity Estimation Step 2
  - Prioritize Heat Map Areas Step 1
  - Prioritize Heat Map Areas Step 2
  - Re-Tune Coverage Gap
  - Reorder Priorities
  - Statistical Hot Spots

Traffic data implementation available in fully revised Heat Map tool (2017 Options). Also available as only additional data option (Heat Map with Traffic) to avoid additional processing time for all options in fully revised tool.

# Revised CHIT Coverage Gap Equation

- CHIT 2015:

$$\text{Heat} = \text{Coverage} * \text{Market}$$

$$\text{Coverage} = 0.5 * \text{Existing} + 0.5 * \text{Potential}$$

$$\text{Market} = 0.5 * \text{Financial} + 0.3 * \text{P/HEV} + 0.2 * \text{Education}$$

$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \text{MSRP} + 0.33 * \text{Luxury}$$

- CHIT 2017 w/ Traffic:

$$\text{Heat} = \text{Coverage} * (0.8 * \text{Market} + 0.2 * \text{Traffic Volume})$$

$$\text{Coverage} = 0.9 * \text{Existing} + 0.1 * \text{Potential}$$

$$\text{Market} = 0.5 * \text{Financial} + 0.3 * \text{P/HEV} + 0.2 * \text{Education}$$

$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \text{MSRP} + 0.33 * \text{Luxury}$$

# CHIT Traffic Webinar

- For more information, see:

<https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.htm>

The screenshot shows a web browser window displaying the California Air Resources Board (ARB) website. The address bar shows the URL: <https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.htm>. The page content is organized into a sidebar and a main content area.

**Sidebar (Left):**

- Regulations
  - Current Regulation
  - Formal Rulemaking Documents
- Workshops / Meetings
- RESOURCES
  - Contact Us
  - Join the CA-Hydrogen Email List
  - RSS / Newsfeed
  - Submit Comments

**Main Content Area:**

**November 2017 Webinar of CHIT 2017 Release Updates**  
Public Notice of Webinar to Discuss CHIT Release Updates

**Map Viewer for June 2017 AB 8 Hydrogen Infrastructure Assessment**  
CARB is making available an updated web application that allows users to view a map containing the locations of existing/funded stations included in analysis, assessments of need for coverage and capacity, and identification of Priority Areas as described in the 2017 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development. View the interactive map of the results produced by CHIT. Please note that use of the app may require the latest version of your internet browser. [Click here](#) for a list of supported browsers.  
[Click here](#) to access the map viewer for the 2015 Analysis and GFO 15-605

**Full CHIT 2017 Release Download Package**  
CARB is making available a download package that contains the CHIT 2017 Release analysis tool for use within ArcGIS 10.2 or later versions. The package contains the ArcGIS CHIT 2017 toolbox, associated files required to run the tools, an instruction manual, input data used for the 2017 June analysis, sample output from the same analysis, and a copy of the June 2017 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development. With this download package and appropriate access to ArcGIS and certain extensions, users will be able to recreate the analyses performed by CARB in support of its June 2017 Annual Evaluation and be able to perform their own exploratory analyses using alternative input data sets, making changes to analysis settings, and/or modifying the analysis algorithms. The CHIT 2017 Release contains several updates that: 1) improve the user experience and simplify re-creation of CARB's analysis, 2) incorporate consideration of simulated traffic flow data, 3) incorporate auto manufacturer projections of vehicle placement, 4) incorporate registered FCEV data, 5) estimate local need for additional hydrogen fueling capacity, 6) re-tuning and updates of input data, parameters, and calculation methods, and other improvements over the 2015 Release. Please note the full download package is 3 GB in size and will require 5.3 GB of space when unpackaged on your computer system. [Click here](#) to download.  
[Click here](#) to access the 2015 Release of CHIT

**March 2017 CHIT Traffic Data Webinar**  
On March 3, 2017 ARB hosted a webinar to review and receive public feedback on a new simulated traffic data set proposed for use in its California Hydrogen Infrastructure Tool (CHIT).  
Public Notice of Webinar to Discuss Simulate Traffic Data for Implementation in CHIT  
Webinar Presentation **NEW!**  
Webinar Recording **NEW!**  
[Attendee List](#) **NEW!**

# AUTO MANUFACTURER SURVEY AND DMV DATA

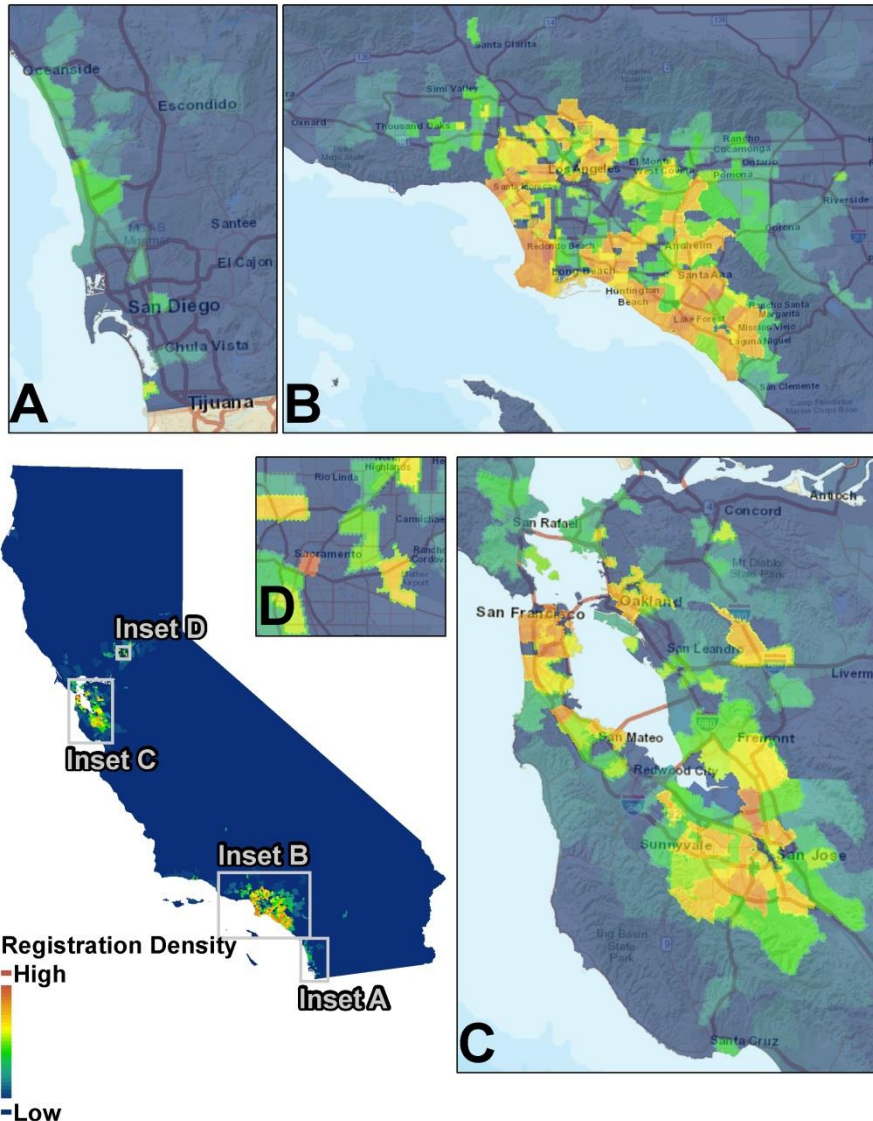
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# Concepts and Motivations

- DMV Registration Data
  - Historically, CHIT and other tools have been intended to analyze forecasted needs for hydrogen fueling
  - No empirical data previously available for existing gaps (other than case-by-case and anecdotal data)
  - As California's network continues to develop, assessment of gaps will need to move away from forecasts and estimates of market potential to empirically-proven market development
- Auto Manufacturer Data
  - CHIT relies on open, public data sets for forecasting and estimating FCEV market potential
  - Input data elements are limited and likely provide only a portion of the full picture
  - Auto manufacturer survey data is a second, independent assessment and may more closely represent direct FCEV intender market

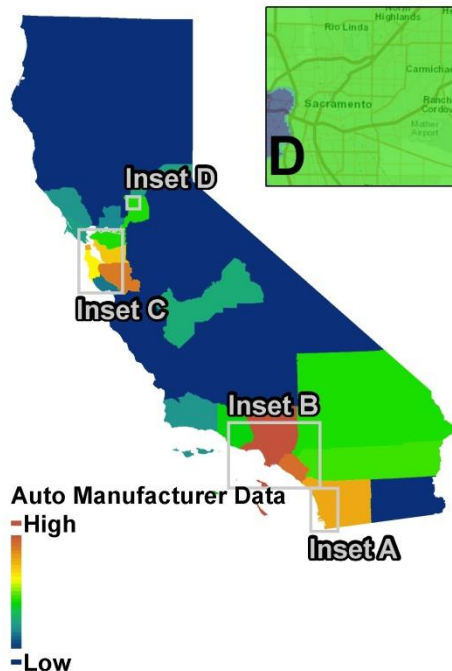
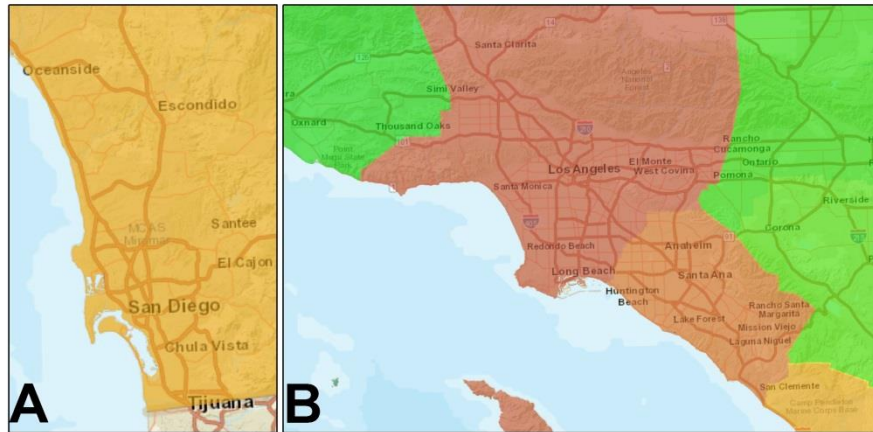


# DMV Registration Data Input



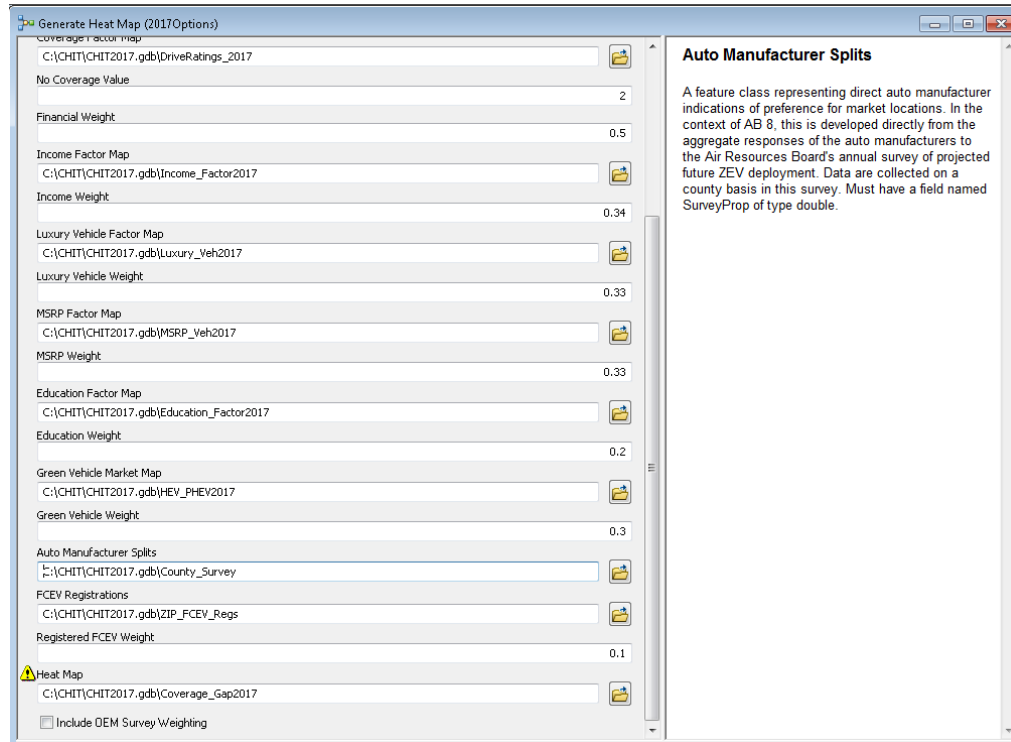
- Based on April 2017 registration data reported in the 2017 Annual Evaluation
- Similar to other market indicators, use spatial densities of vehicle deployments on a ZIP-code basis (count/sq mi)
- Total of 1,609 FCEVs throughout the state
- Applied to market evaluation portion of coverage gap as an additive factor with other indicators

# Auto Manufacturer Data Input



- Based on April 2017 auto manufacturer survey data, administered under the AB 8 program and reported in the 2017 Annual Evaluation
- Spatial resolution is limited by the format of the survey (county-level)
- Due to low spatial resolution, data are not considered on an area density basis
- Applied as overall scaling factor to market evaluation

# Using FCEV Deployment Data



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  - Reorder Priorities
  - Statistical Hot Spots

DMV and auto manufacturer implementation available in fully revised Heat Map tool (2017 Options).

Auto manufacturer data implemented as a switch (see next slide).

# Revised CHIT Coverage Gap Equation

- CHIT 2015:

$$\text{Coverage Gap} = \text{Coverage} * \text{Market}$$

$$\text{Coverage} = 0.5 * \text{Existing} + 0.5 * \text{Potential}$$

$$\text{Market} = 0.5 * \text{Financial} + 0.3 * \text{P/HEV} + 0.2 * \text{Education}$$

$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \text{MSRP} + 0.33 * \text{Luxury}$$

- CHIT 2017 w/ all Optional Data:

$$\text{Coverage Gap} = \text{Coverage} * (0.8 * \text{Market} + 0.2 * \text{Traffic Volume})$$

$$\text{Coverage} = 0.9 * \text{Existing} + 0.1 * \text{Potential}$$

$$\text{Market} = 0.9 * (0.5 * \text{Financial} + 0.3 * \text{P/HEV} + 0.2 * \text{Education}) + 0.1 * \text{DMV Regs}$$

or (if Auto Data Switch Set):

$$\text{Market} = (0.9 * (0.5 * \text{Financial} + 0.3 * \text{P/HEV} + 0.2 * \text{Education}) + 0.1 * \text{DMV Regs}) * \text{Auto Data}$$

$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \text{MSRP} + 0.33 * \text{Luxury}$$

# COVERAGE GAP RE-TUNING

---

# Motivation

- CHIT 2017 Release expands the possible options for input data considered, all associated with individual weighting factors
- CHIT users may be interested in sensitivity analyses to assess the appropriate weighting factor for each input data set
- Full coverage gap calculation hours long because of aligning and joining of several data inputs
- However, for a re-calculation, do not need to perform spatial aligning if base data sets remain the same
- New tool takes advantage of this to complete a coverage gap re-assessment in a short period



# Using Re-Tuning Tool

**Re-Tune Coverage Gap**

Re-tunes the input parameter weighting for a heat map of localized desirability/need for new hydrogen refueling station(s). The tool takes advantage of the data spatial alignment completed by a previous run of the Generate Heat Map (2017 Options) tool. This tool can only be used with a base coverage gap map generated with 2017 Options version of the Generate Heat Map tool.

This tool is provided for quick re-calculation of coverage gap with new input factor weightings. The tool requires a base coverage gap map that has previously been calculated with a set of weighting values for all input data. For users who simply want to investigate different weightings on input factors (and not investigate alternative data sets), this tool can be used to quickly re-calculate the coverage gap under the assumption of a revised set of weighting values.

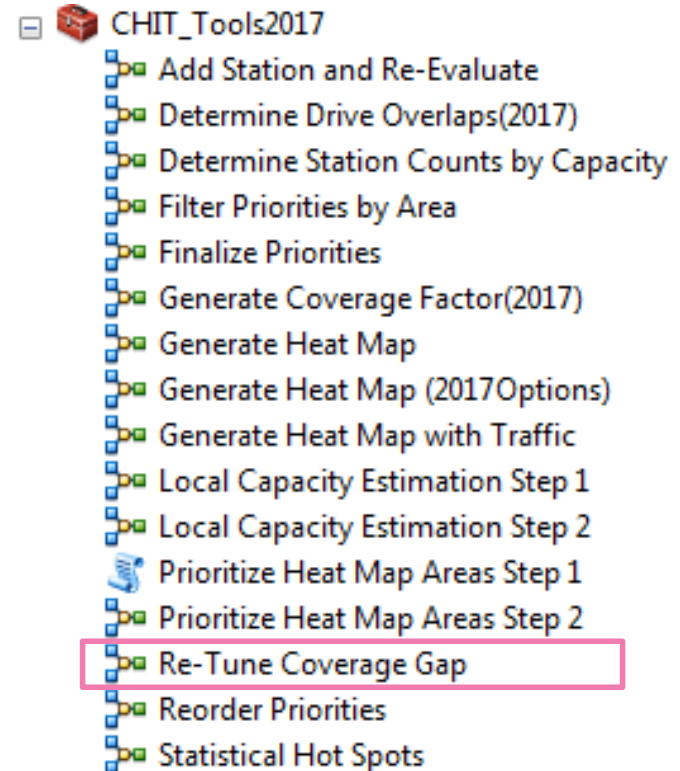
If the base coverage gap map is displayed in arcmap at the same time this tool is run, it may be necessary to reclassify the visualization of HeatScore\_CxM after the tool completes in order to properly visualize the new results.

As a reminder, the coverage gap is represented by the following set of equations:

$$\text{HeatScore} = \text{CoverageScore} * (x * \text{Market Score} + y * \text{Drive Volume Score})$$

$$\text{Financial} = f * \text{Income} + g * \text{Luxury Vehicles} + h * \text{Vehicle MSRP}$$

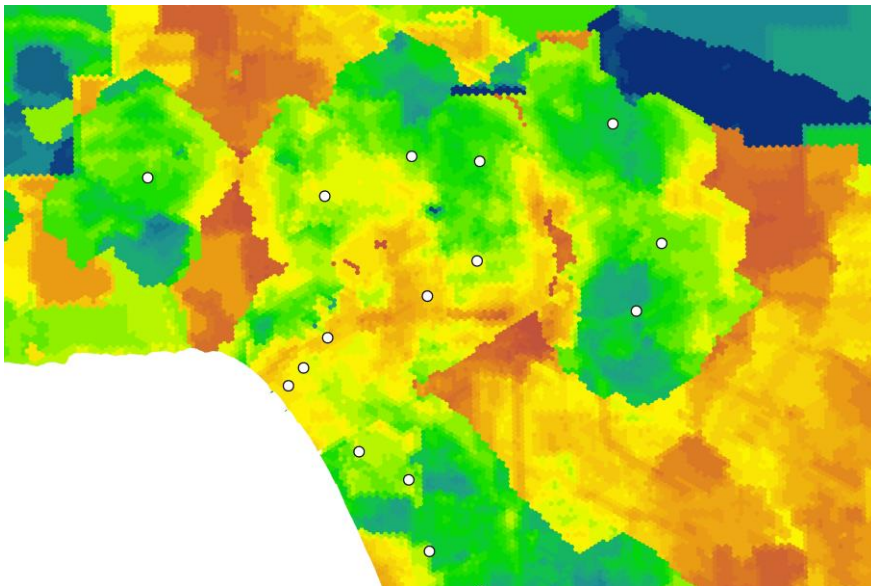
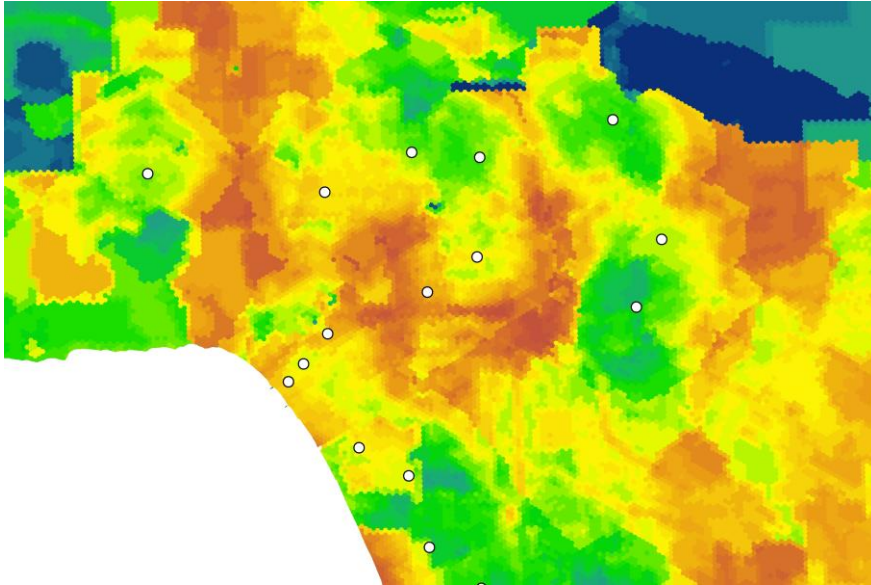
If b (Access Weight) is set to any value other than 0:

$$\text{CoverageScore} = a * \text{Existing Coverage} + b * \text{Potential}$$


## NOTES:

- Base Coverage Map must be developed only with the Generate Heat Map (2017 Options) tool (or the Re-Tuning tool beginning with such a map)
- The No Coverage Value parameter is defined *relative* to the value used to calculate the Base Coverage Map
- This tool modifies the Base Coverage Map file. It does not generate a new feature class; users should backup the Base Coverage Map if it is desirable to keep the base map

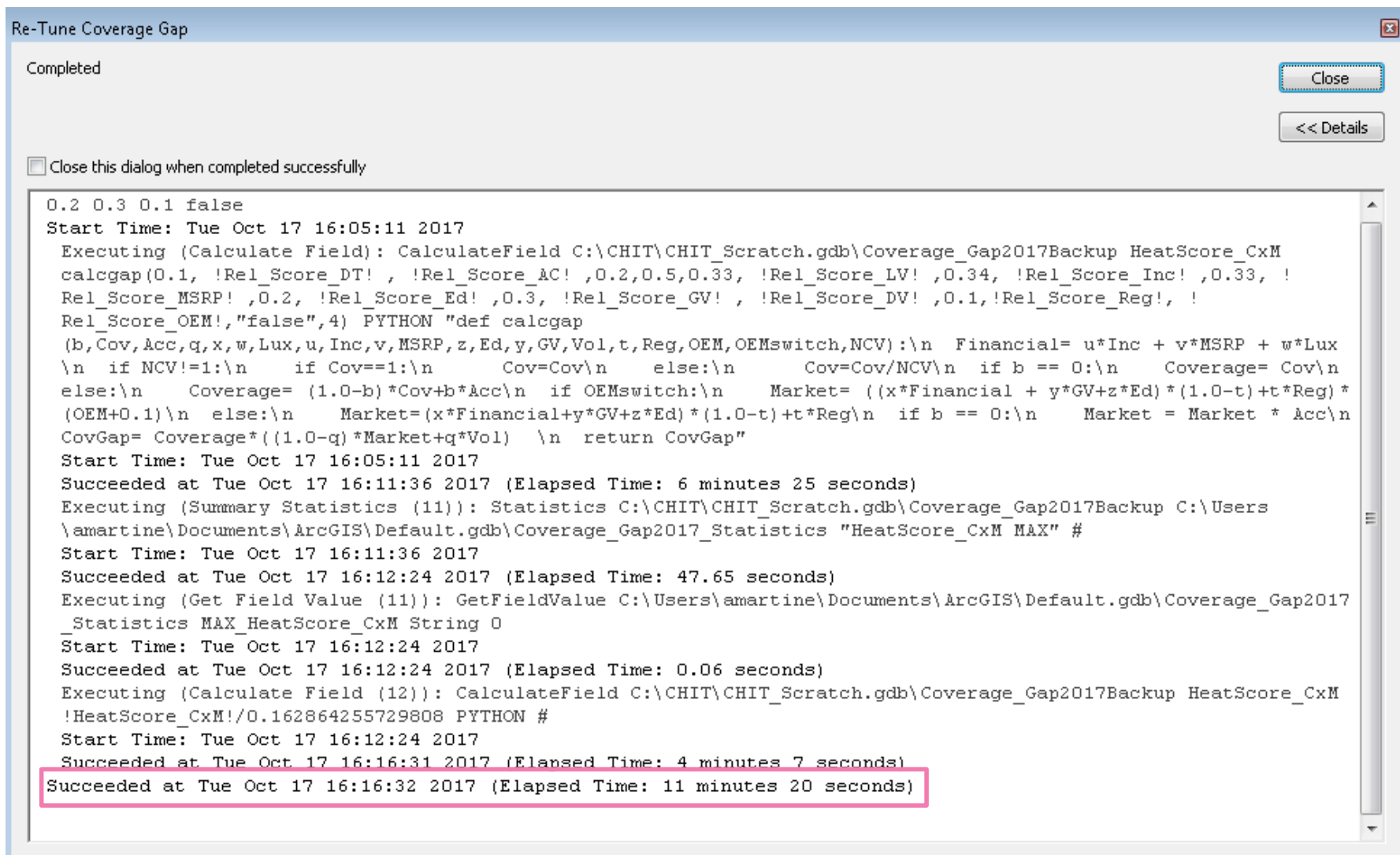
# Example of Retuning



- Example shows Coverage Gap as calculated in 2017 Annual Evaluation in West LA region in top figure
- Bottom figure shows effect of quadrupling the priority placed on areas with no coverage provided at all (by setting the No Coverage Value in the Re-Tuning Tool to 4)
- White dots indicate locations of funded stations



# Example of Retuning



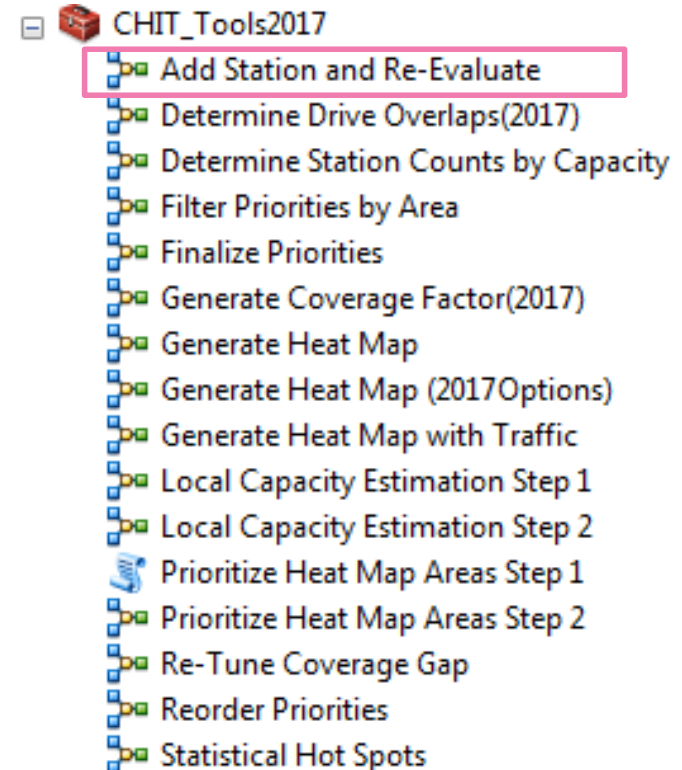
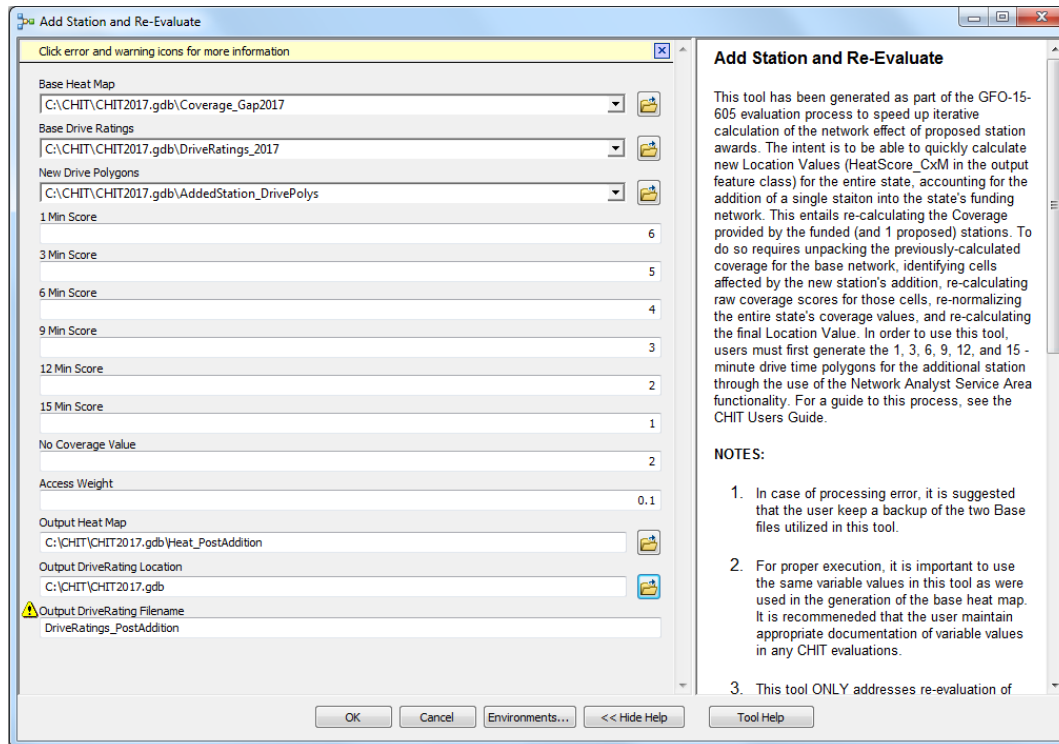
# SINGLE STATION RE- EVALUATION

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# Motivation

- First developed as a tool to quickly implement iterative evaluation process of GFO-15-605
  - GFO-15-605 first solicitation where the “network effect” of each proposed award explicitly evaluated
  - After a station award selected, CHIT data (coverage gap and capacity need) adjusted to account for impact of that station
  - All stations’ Coverage, Capacity, and Market Viability scores reconsidered on the basis of this updated analysis
  - Repeated for every award in NOPA-15-605 (each iteration referred to in NOPA as a “CHIT Round”)
- Full coverage gap calculation hours long because of aligning and joining of several data inputs
- However, for a re-calculation, do not need to perform spatial aligning if calculation inputs known
- New tool takes advantage of this to complete a coverage gap re-assessment in roughly 20 minutes

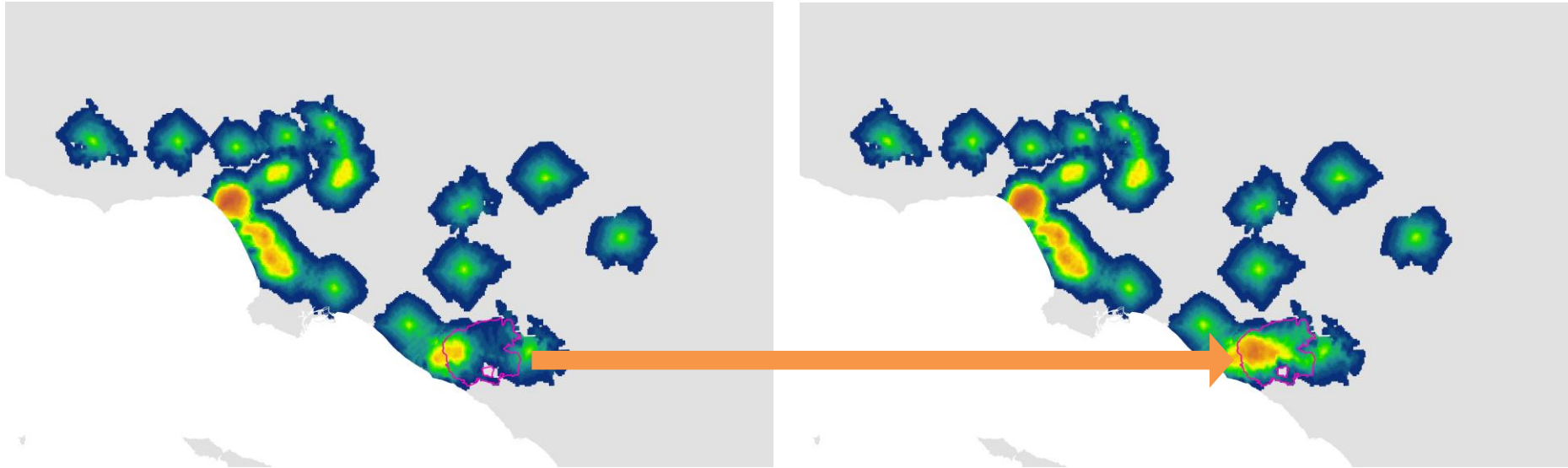
# Using Coverage Re-Evaluation



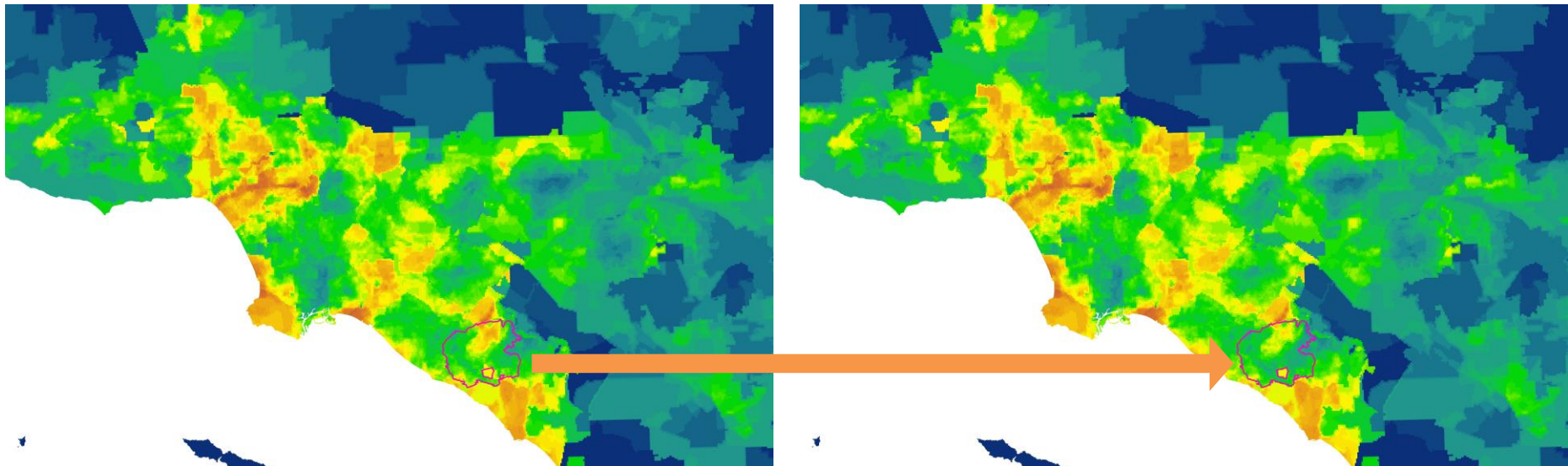
## NOTES:

- Must first complete a Service Area calculation for the new station placement
- Able to recalculate Coverage Gap map generated with any version of Generate Heat Map
- Does not make any adjustment to market side of evaluation
- Does not re-calculate capacity need
- Faster than full Generate Heat Map process for a single station
- Can be used iteratively for multiple stations though after ~15 stations, this tool is slower

# Coverage Re-Evaluation Example



Final GFO 15-605 CHIT Round: Evaluation after Addition of 5333 University Dr (Irvine)



# ALTERNATIVE COVERAGE GAP FORMULA

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# Motivation

- Through the exercise of the iterative evaluation in GFO-15-605, CARB noted that coverage gap was more heavily controlled by population density (captured in the "Potential" Coverage data factor) than initially desired
- CARB performed sensitivity analysis and determined that the weight attributed to this factor (previously 0.5 in CHIT 2015 Release) needed to be exceedingly small in order for population density not to be the most important factor in coverage gap evaluations
- CARB proposed that another solution was to re-cast the "Potential" Coverage factor as a scaling factor on market evaluation rather than as an additive factor in the coverage evaluation

# Alternative CHIT Coverage Gap Equation

- CHIT 2017 w/ all Optional Data:

$$\text{Coverage Gap} = \text{Coverage} * \\ (0.8 * \text{Market} + \\ 0.2 * \text{Traffic Volume})$$

$$\text{Coverage} = 0.9 * \text{Existing} + \\ 0.1 * \text{Potential}$$

$$\text{Market} = (0.9 * (0.5 * \text{Financial} + \\ 0.3 * \text{P/HEV} + 0.2 * \\ \text{Education}) + 0.1 * \\ \text{DMV Regs}) * \text{Auto Data}$$

$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \\ \text{MSRP} + 0.33 * \text{Luxury}$$

- CHIT 2017 Alternative:

$$\text{Coverage Gap} = \text{Coverage} * \\ (0.8 * \text{Market} + \\ 0.2 * \text{Traffic Volume})$$

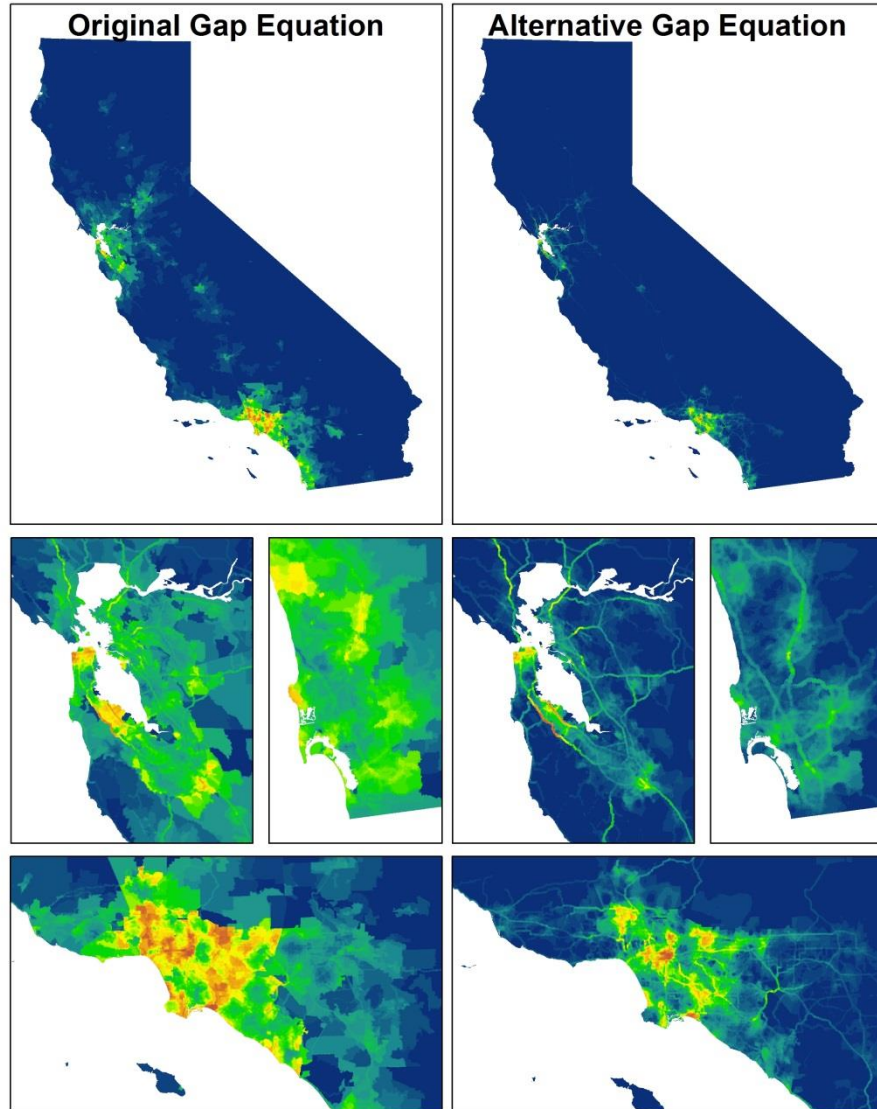
$$\text{Coverage} = \text{Existing}$$

$$\text{Market} = (0.9 * (0.5 * \text{Financial} + \\ 0.3 * \text{P/HEV} + 0.2 * \\ \text{Education}) + 0.1 * \\ \text{DMV Regs}) * \\ \text{Auto Data} * \text{Potential}$$

$$\text{Financial} = 0.34 * \text{Income} + 0.33 * \\ \text{MSRP} + 0.33 * \text{Luxury}$$



# Using Alternative Coverage Gap Formulation



- Can be implemented in Coverage Gap calculation tools (including Re-Tune Coverage Gap) by setting the weight for the Potential Coverage (called "Access Factor" in the tools) to 0
- With all other factor weights left unchanged, CARB found that results were too spatially limited
- 2017 Annual Evaluation does not use this formulation but will continue to be investigated at CARB and provided in tool for stakeholder investigation

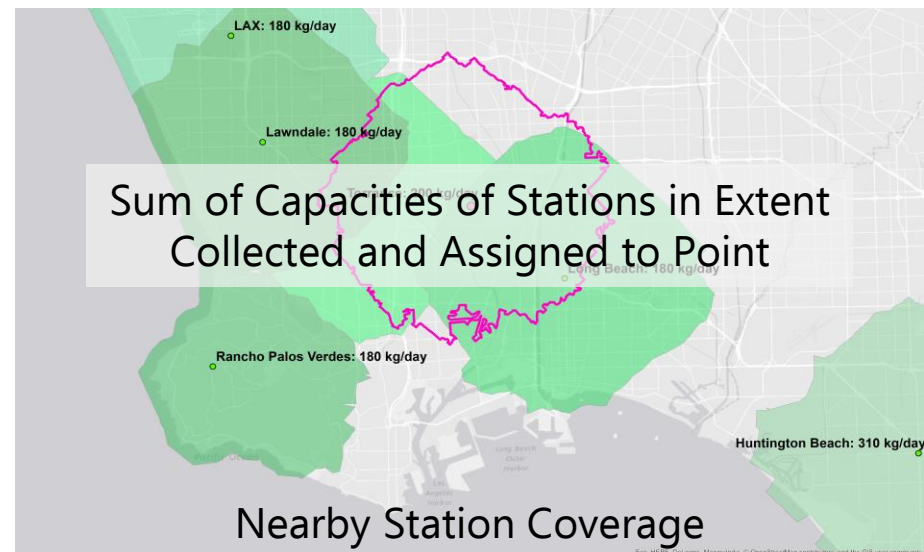
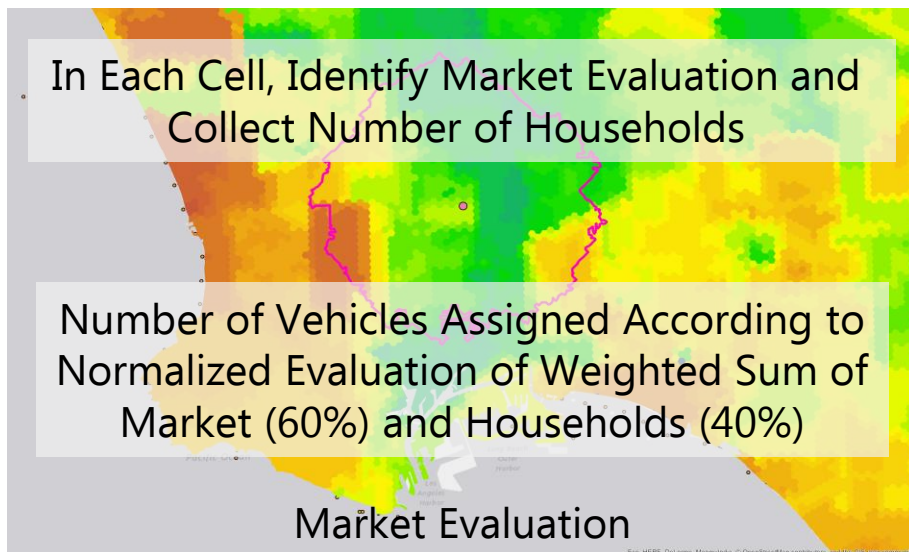
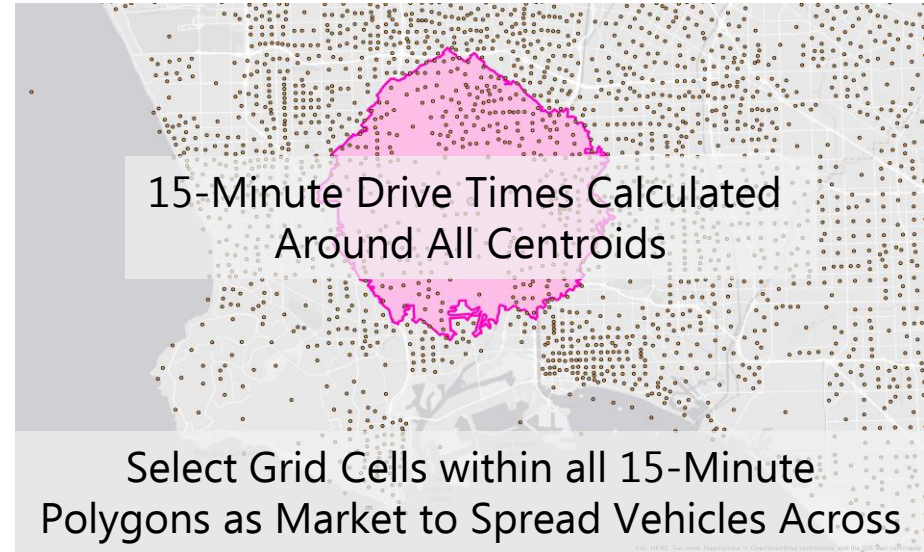
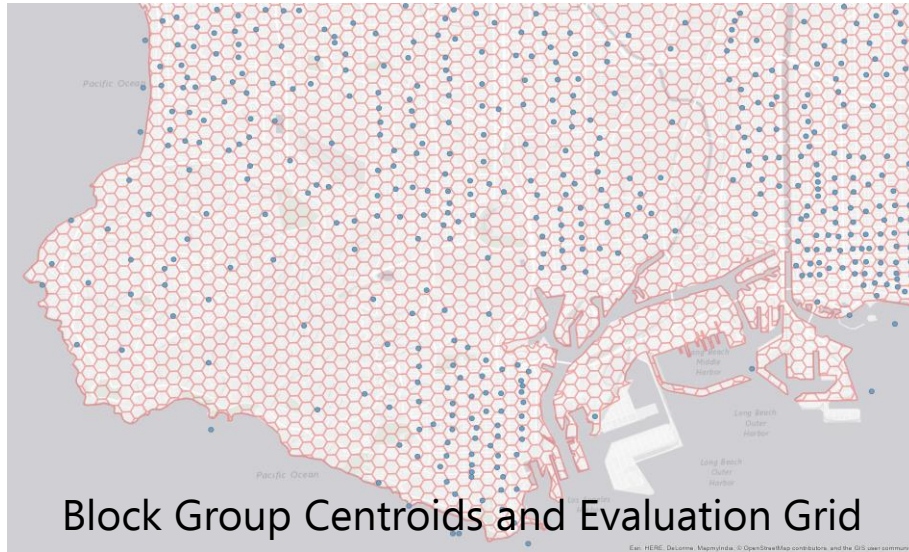
# LOCAL CAPACITY NEED

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# Motivation

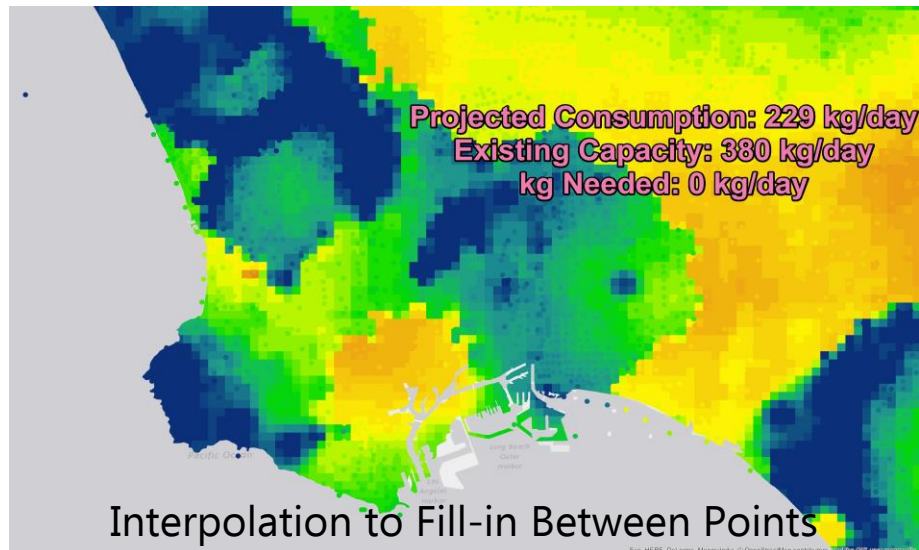
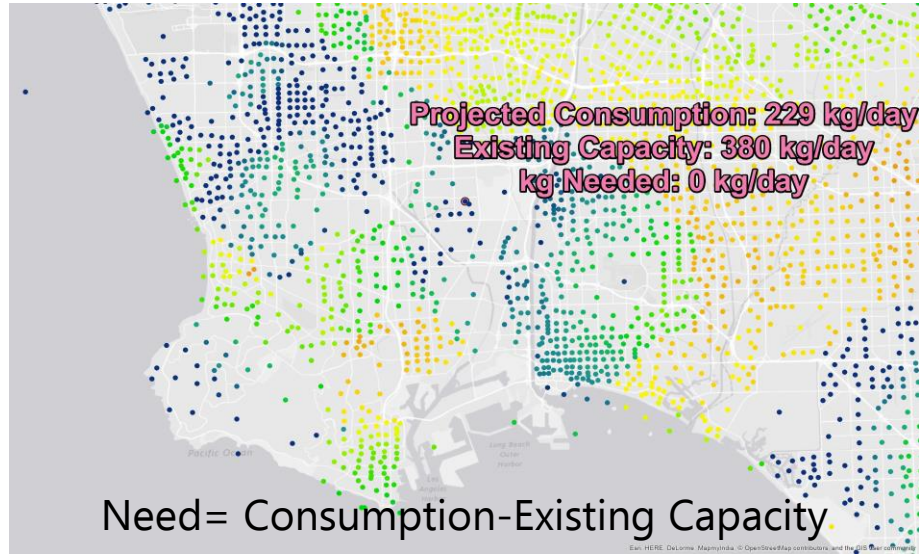
- First created to aide decision-making process for GFO 15-605
- Estimates localized capacity need based on auto manufacturer survey data and extent of coverage provided by funded stations
- Capacity need is a localized, continuous value across the state
  - The total of all cells is much larger than the total need for the assumed number of vehicles
  - Interpolation step adds spatial variation according to distance from stations, even outside range of a station's coverage

# Capacity Need Estimation Process



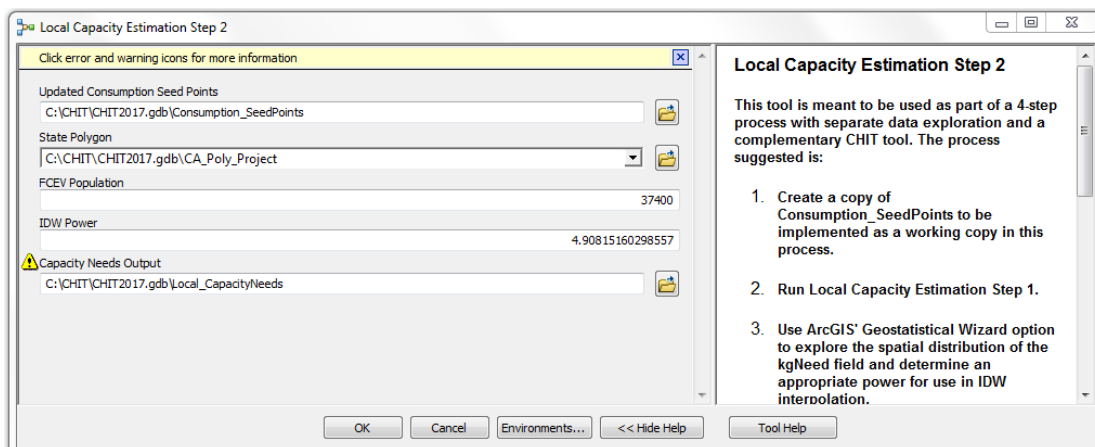
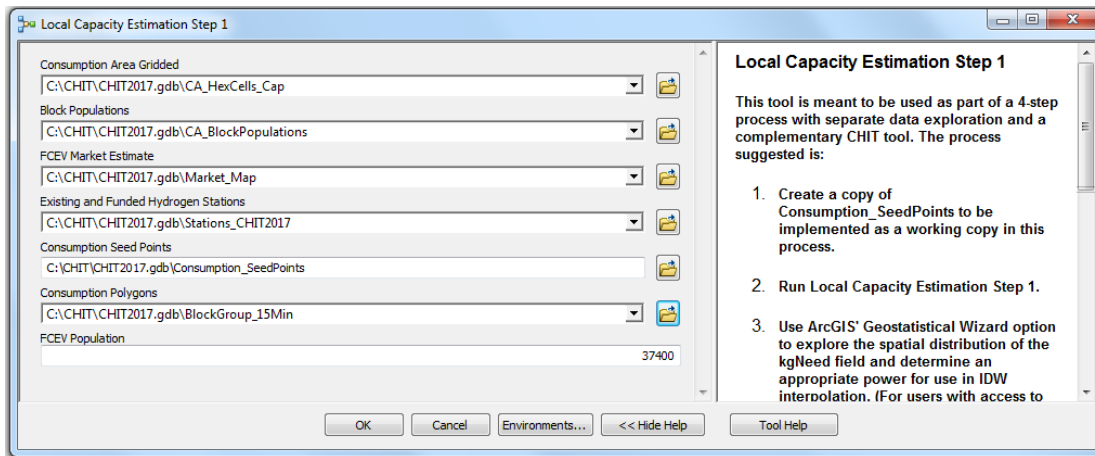


# Capacity Need Estimation Process



- Interpolation relies on built-in ArcGIS methods
- Process has been divided into two steps to allow tuning of interpolation
- Interested users can explore impacts of re-tuning the interpolation after Step 1
  - Requires access to Geostatistical Analyst Extension
  - Users without this access can either accept defaults or iteratively use trial-and-error in Step 2
  - Step 2 interpolation has been built assuming only Inverse Distance Weighting (IDW) interpolation method

# Using Local Capacity Estimation

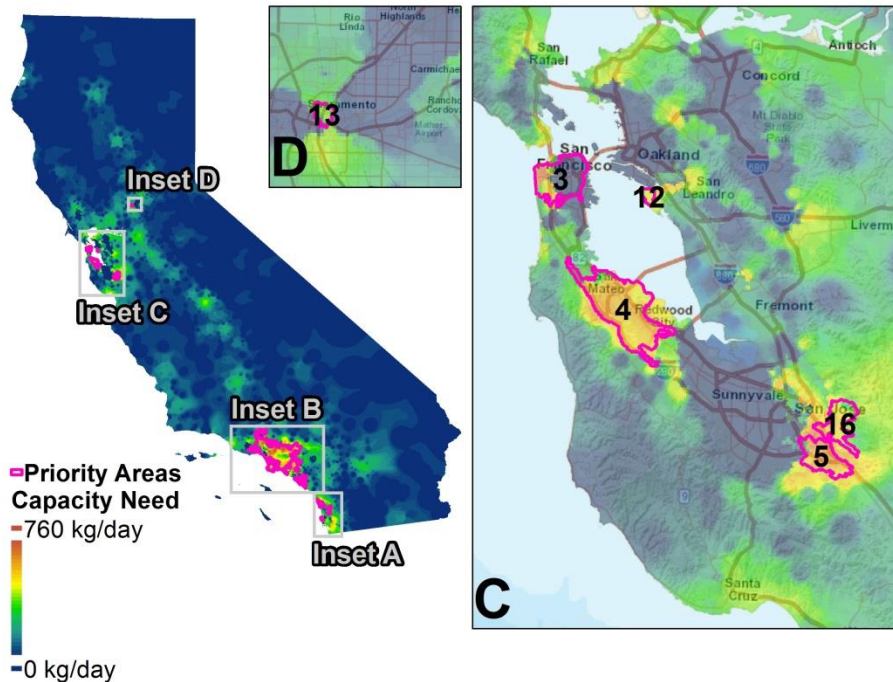
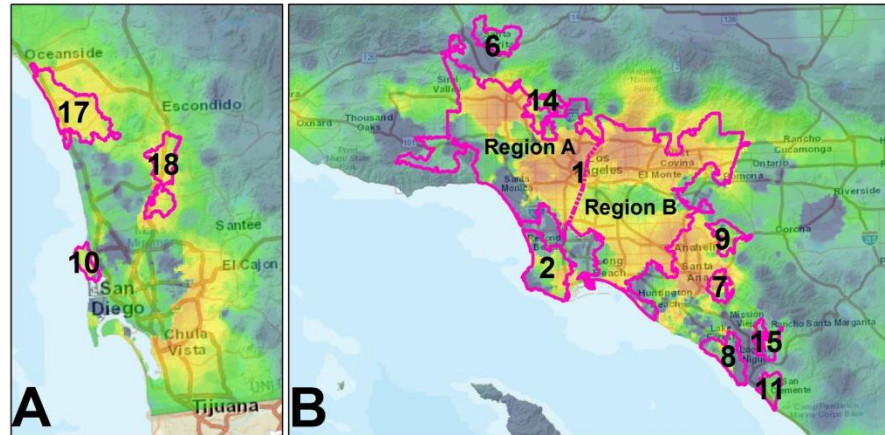


- CHIT\_Tools2017
- Add Station and Re-Evaluate
  - Determine Drive Overlaps(2017)
  - Determine Station Counts by Capacity
  - Filter Priorities by Area
  - Finalize Priorities
  - Generate Coverage Factor(2017)
  - Generate Heat Map
  - Generate Heat Map (2017Options)
  - Generate Heat Map with Traffic
  - Local Capacity Estimation Step 1
  - Local Capacity Estimation Step 2
  - Prioritize Heat Map Areas Step 1
  - Prioritize Heat Map Areas Step 2
  - Re-Tune Coverage Gap
  - Reorder Priorities
  - Statistical Hot Spots

# Using Local Capacity Estimation

- Local Capacity Estimation Step 1 overwrites the Consumption\_SeedPoints feature class with new calculated data
- CARB recommends maintaining a clean copy of Consumption\_SeedPoints\_Temp as a convenient backup of the initialized feature class so it can be used to re-initialize after previous evaluations
- Local Capacity Estimation Step 2 requires the modified Consumption\_SeedPoints output of Step 1
- 15-minute drive time polygons and consumption seed points provided in CHIT2017 have synched data fields for matching
  - Necessary for processing steps to associate “captured” demand with each consumption seed point
  - CHIT Users’ Guide v2 provides guidance for users to create their own files in case they wish to use their own set of consumption seed points
- See CHIT Users’ Guide v2 for important notes on processing settings for stable execution

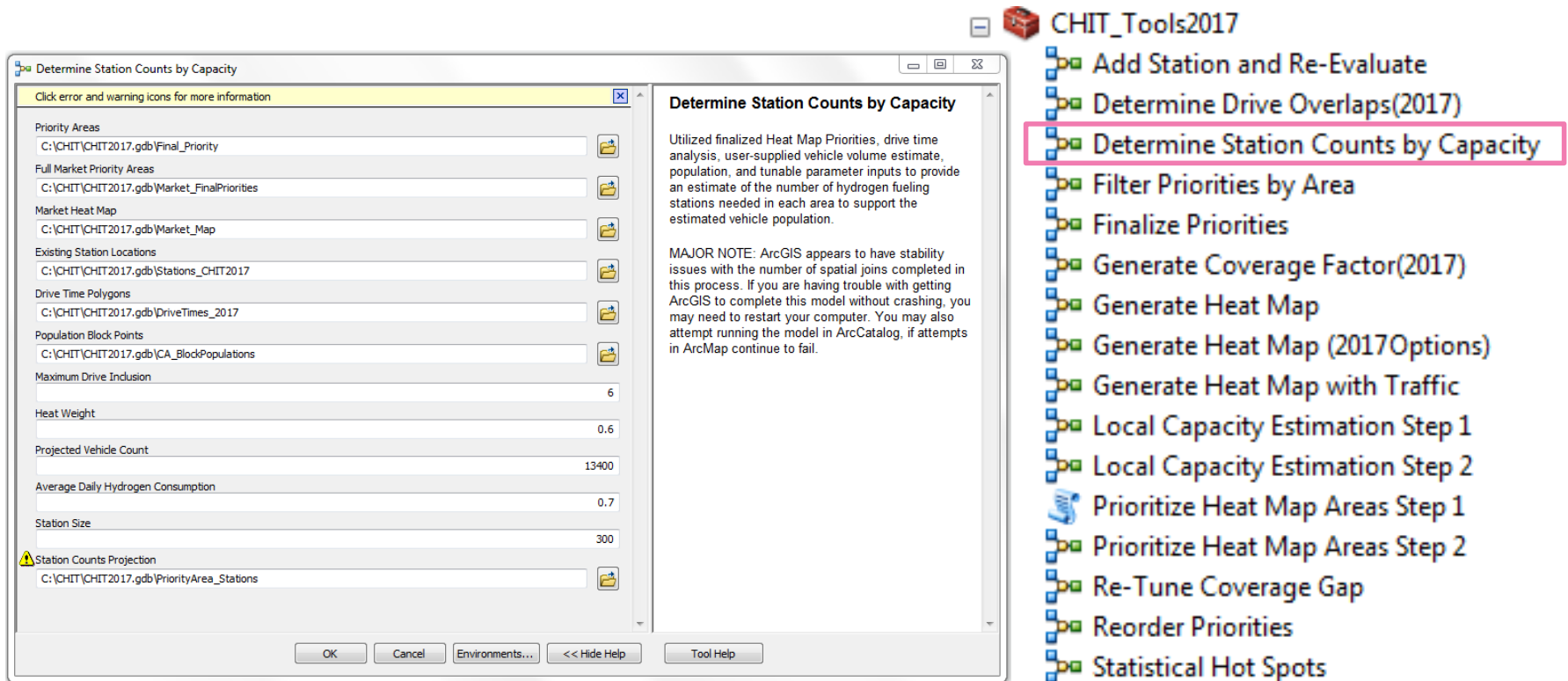
# Localized Capacity Need in CHIT 2017



- Provides direct calculation of capacity metric as separate from coverage metric referenced in AB 8 and other efforts
- Coverage and capacity similar and related, but can be very different locally
- Spotty appearance (especially in low-need areas) by-product of interpolation method



# A Note on Priority Area Capacity Needs



## NOTES:

- CHIT 2015 Release included a tool for determining the number of stations (based on user-provided station capacity and FCEV deployment assumptions) needed in Priority Areas
- The tool's main purpose is to determine number of stations needed in each Priority Area
- The tool's math DOES preserve total capacity need for a given FCEV deployment volume
- An updated version of this tool is still available in CHIT 2017 Release
- The Priority Area needs and Local Capacity tools have similar characteristics but are fundamentally different in intended use and interpretation

# EVALUATION GRID UPDATE

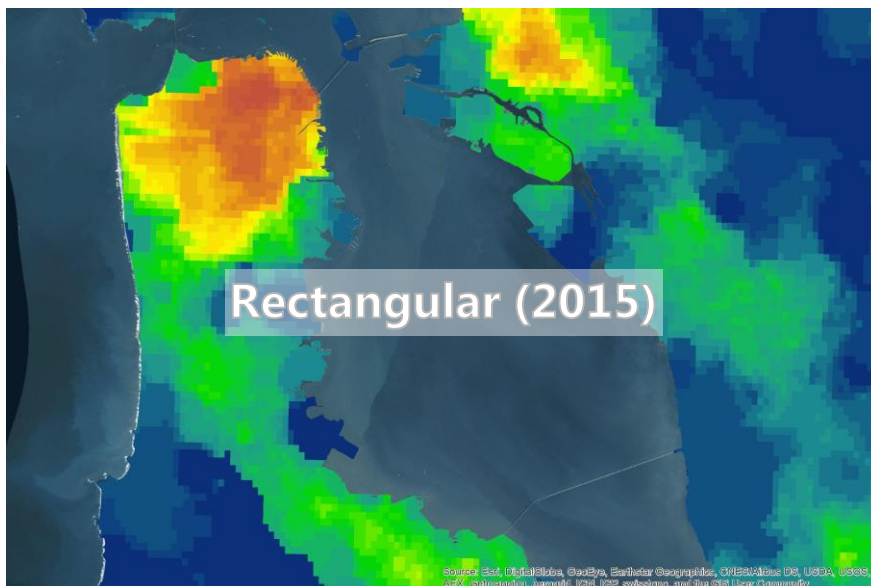
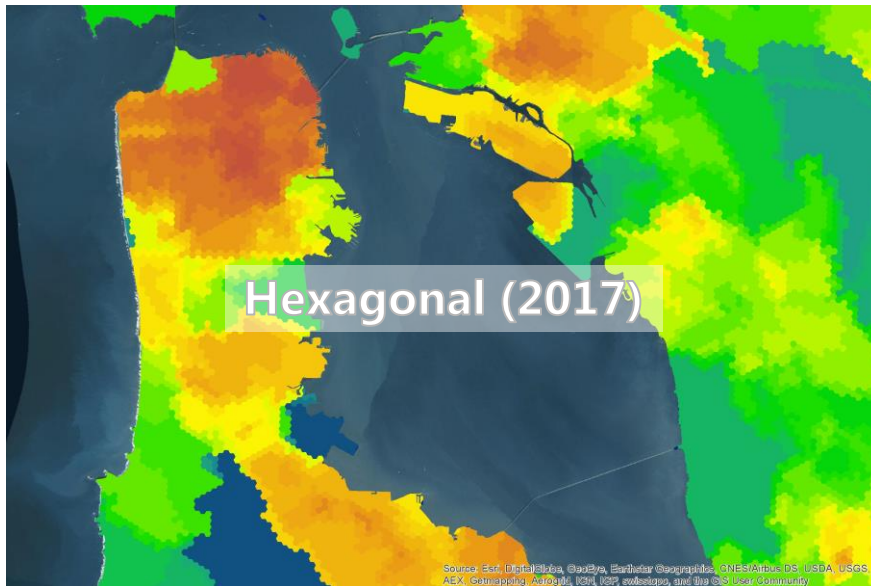
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# Standardized Coordinate System



- Part of CARB-wide effort to standardize GIS data products
- Agreed-upon agency-wide coordinate system is Projected State-Based NAD 1983 California Teale-Albers (CARB has implemented the 2011 update for CHIT 2017 Release)
- Effect should be transparent to majority of users
- ArcGIS has extensive routines and methods to automatically manage combining data sets with varying coordinate systems
- CHIT 2017 Release default data all provided in this coordinate system, but can still be used with data in other coordinate systems

# Hexagonal Analysis Grid



- New analysis grid implemented in CHIT 2017 Release
- Analysis grid is basis of geometries used to aggregate spatial distribution of underlying data inputs
- Modern GIS pursuits and tools have recognized several benefits of a hexagonal grid compared to a rectangular grid (see CHIT Users Guide v2 for discussion)
- Hexagonal grids' largest disadvantage to a CHIT user is increased number of vertices, which translates to increased calculation load in GIS systems

# DEMOGRAPHIC DATA UPDATES AND CVRP

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# CHIT Demographic Principles

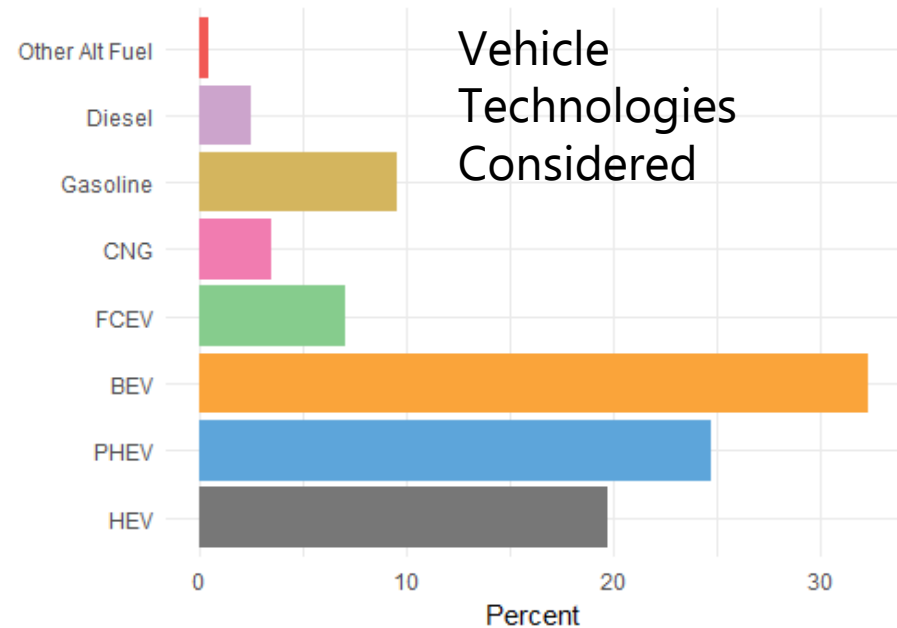
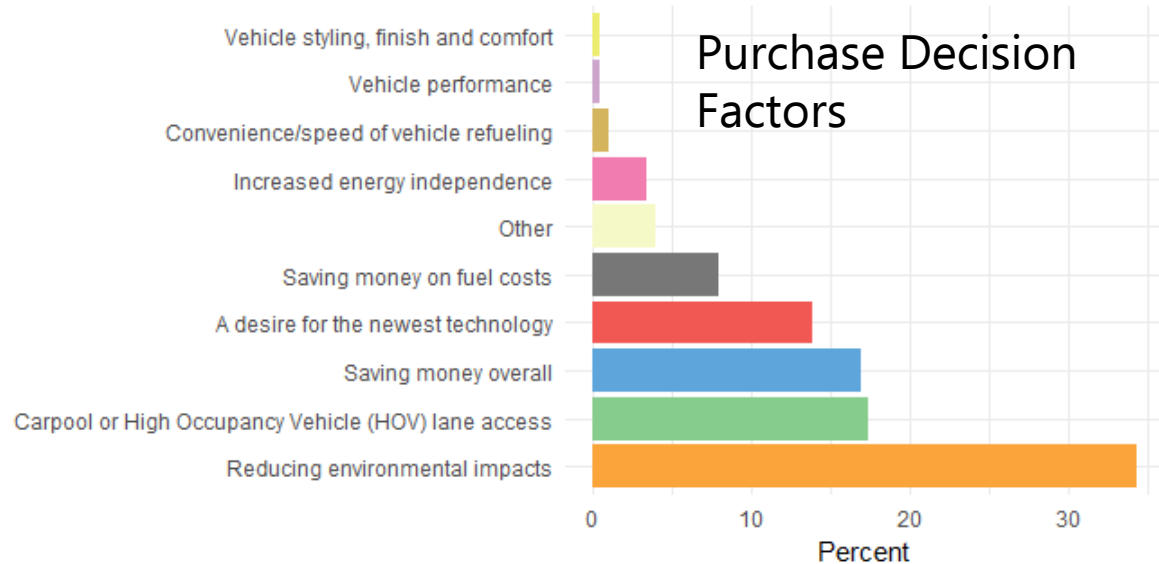
- Principle #3: CHIT assesses only the first adopter market
- Principle #4: Identification of the FCEV owner market can be estimated by consideration of the relative distribution of multiple demographic indicators; the total fueling market potential can be estimated by consideration of both the owner market and commonly-traveled routes
- Demographic-based indicators used in CHIT:
  - Household income
  - Rates of graduate degree attainment
  - Past green vehicle adoption rates (PHEV/HEV)
  - Past luxury vehicle brand adoption rates
- Income, Education from US Census Bureau's American Community Survey. Updated to latest available for CHIT 2017.
- Vehicle adoption data from DMV historical records. Luxury vehicles updated to trends for last 5 years. Green vehicle data (PHEV rates in first adopter period) now completely specified in CHIT 2017.

# Motivation

- Fundamental principles and selection of data inputs for market evaluation based on assumptions, expectations, and prior research of indicators for likelihood of FCEV adoption
  - Many of these indicators are more general for “green” or “new” technology adoption overall
  - California, among other jurisdictions worldwide, is one of the first places where factors indicating likelihood of adoption can be empirically evaluated
- The Clean Vehicle Rebate Project (CVRP) includes optional surveys for FCEV purchases to provide feedback to CARB
  - A purchase decision survey is currently the only active survey
  - Follow-on surveys are in development and will be offered for ongoing input from FCEV adopters

# Purchase Motivations

- Reducing environmental impacts #1 purchase motivator
- FCEV chosen with significant amount of technology cross-shopping

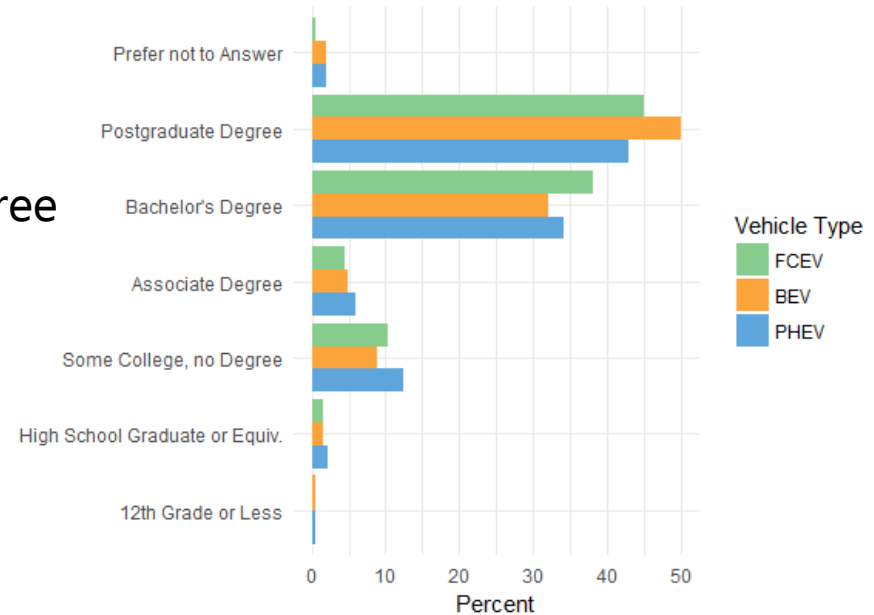




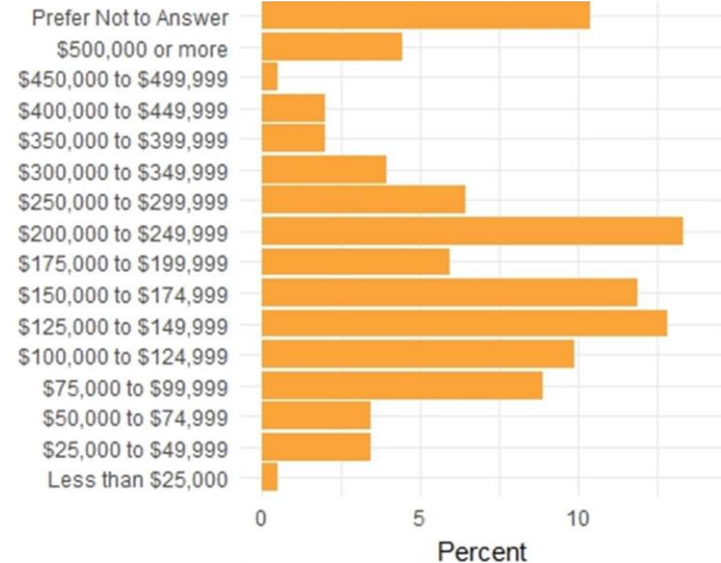
# Demographics

- CHIT uses demographic indicators of income and education attainment
- Survey responses seem in line with educational factor use
- Income considered by CHIT may be higher than responses

FCEV Adopters  
Highest Degree  
Attained



Distribution of  
FCEV Adopters  
Household  
Income



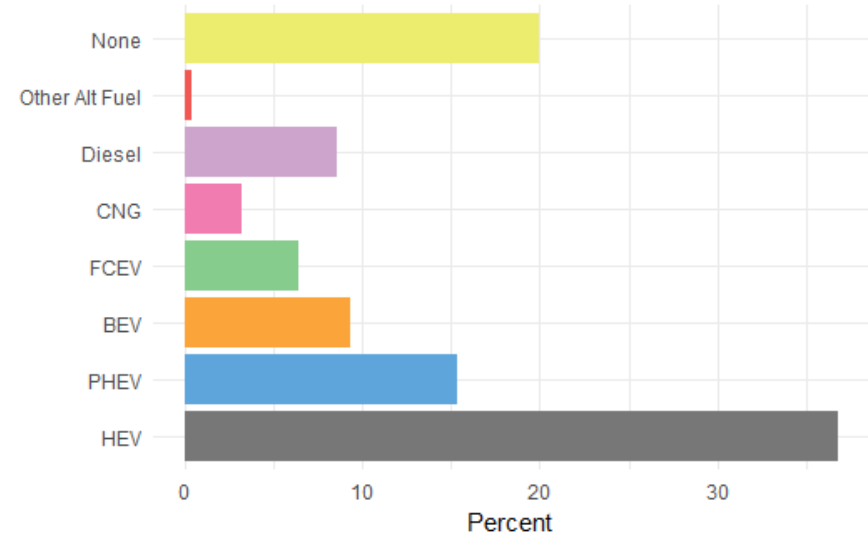
# Past Vehicle Purchase Indicators

- Past green vehicle adoption used in CHIT as indicator for FCEV adoption

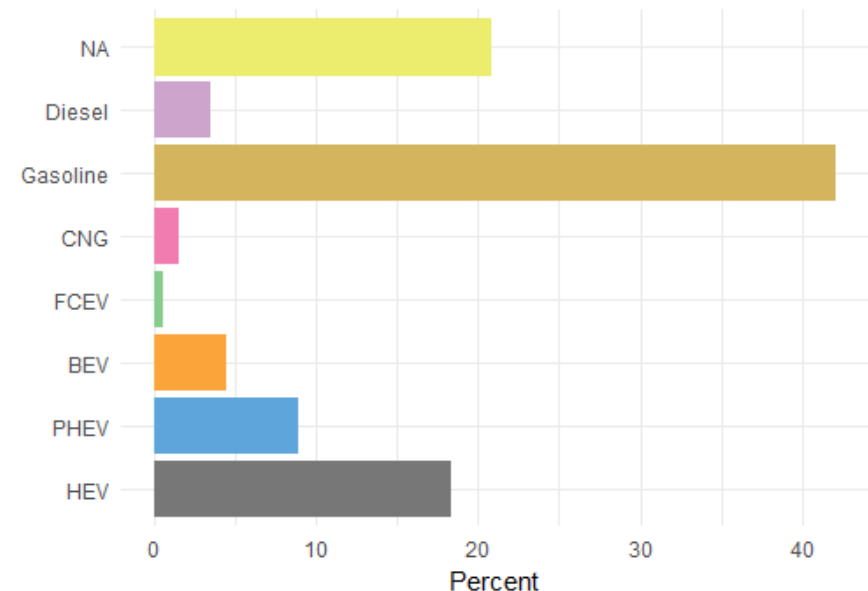
- Implemented as HEV/PHEV (not BEV)

- Survey data appear to support method

Past  
Alternative  
Fuel Vehicle  
Ownership

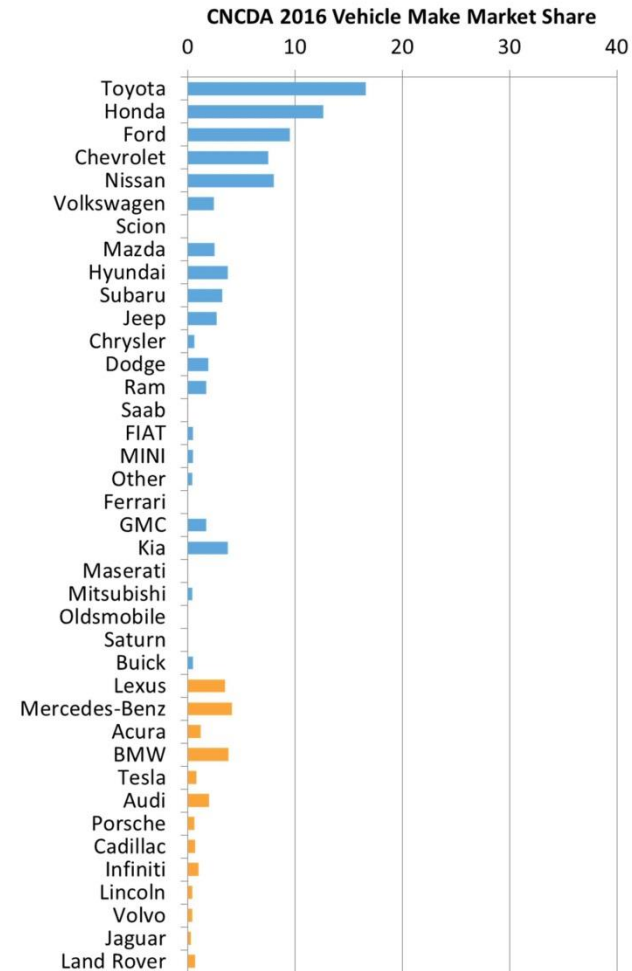
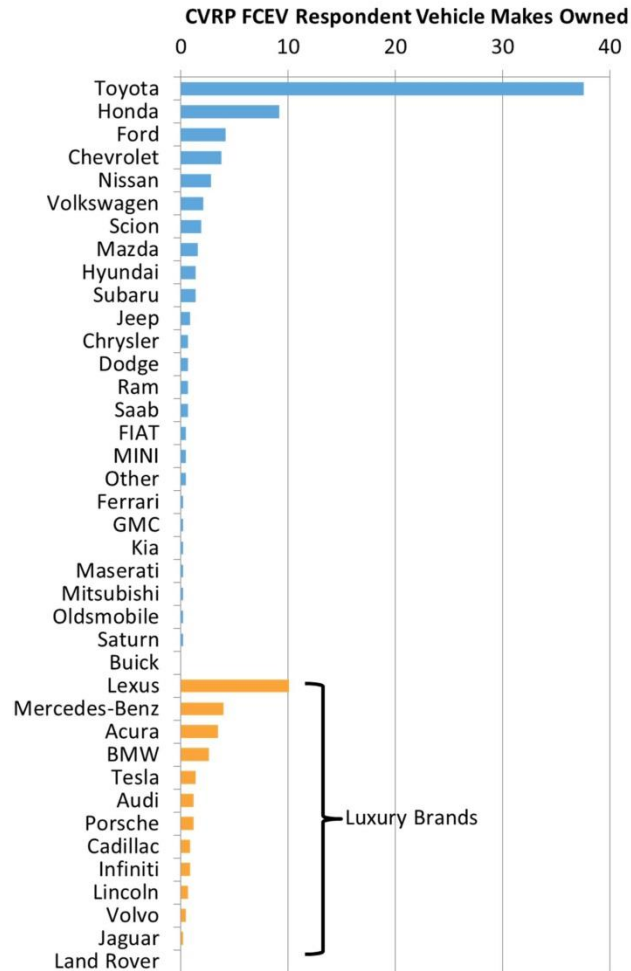


Technology  
of Vehicle  
Replaced



# Past Vehicle Purchase Indicators

- Luxury vehicle branding previously cited as potential indicator for FCEV adoption
- May be slightly more affinity in FCEV adopters, but maker loyalty and differences in deployment plans may also play a role



Other vehicle makes owned by adopters vs. new car market

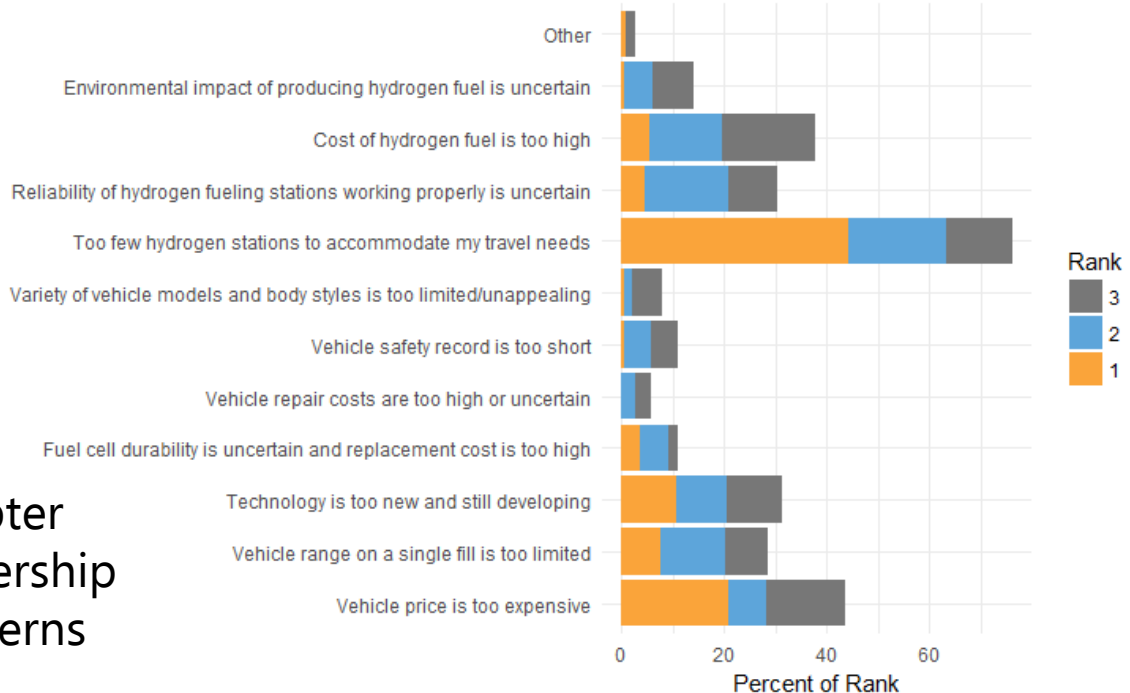
# CHIT Coverage Principle

Principle #6: Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes and/or within proximity to commonly-traveled routes

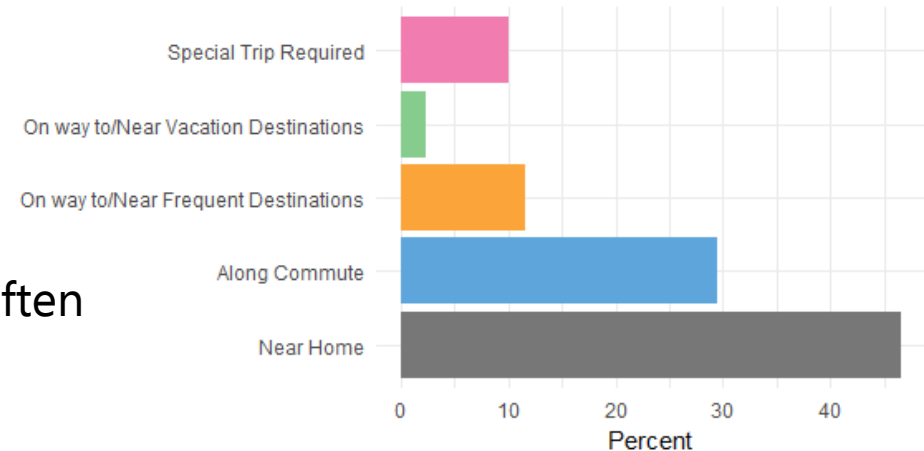
# Importance of Station Locations

- Stations are early adopters' primary concern
- Price (vehicle and fuel) were second largest concern
- Drivers most often fueling near home

## FCEV Adopter Ownership Concerns



## Location FCEV Drivers Most Often Currently Fuel

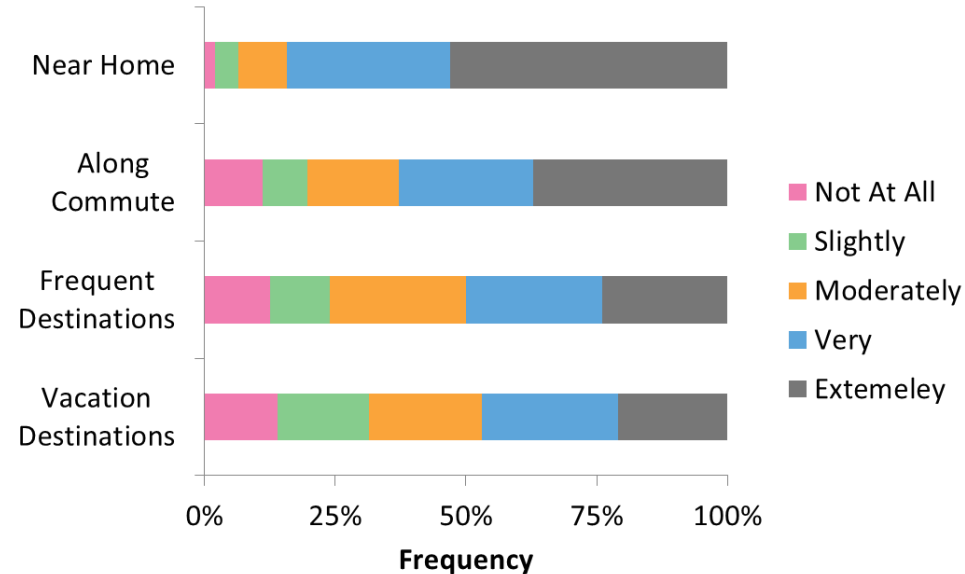


# Importance of Station Locations

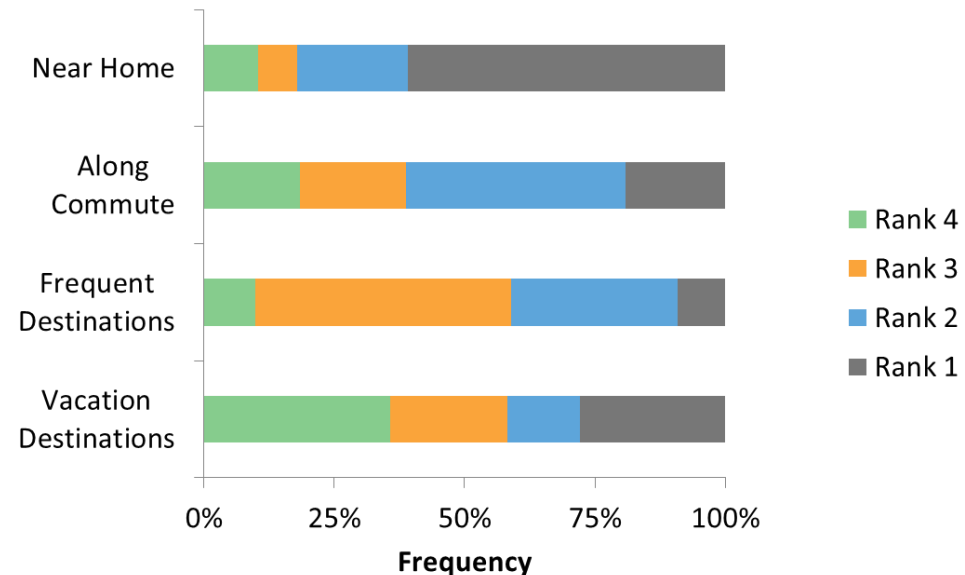
- Locations of stations affect the purchase decision based on their location relative to the FCEV adopter

- Additional near-home location most needed

Importance of Various Station Locations in Purchase Decision



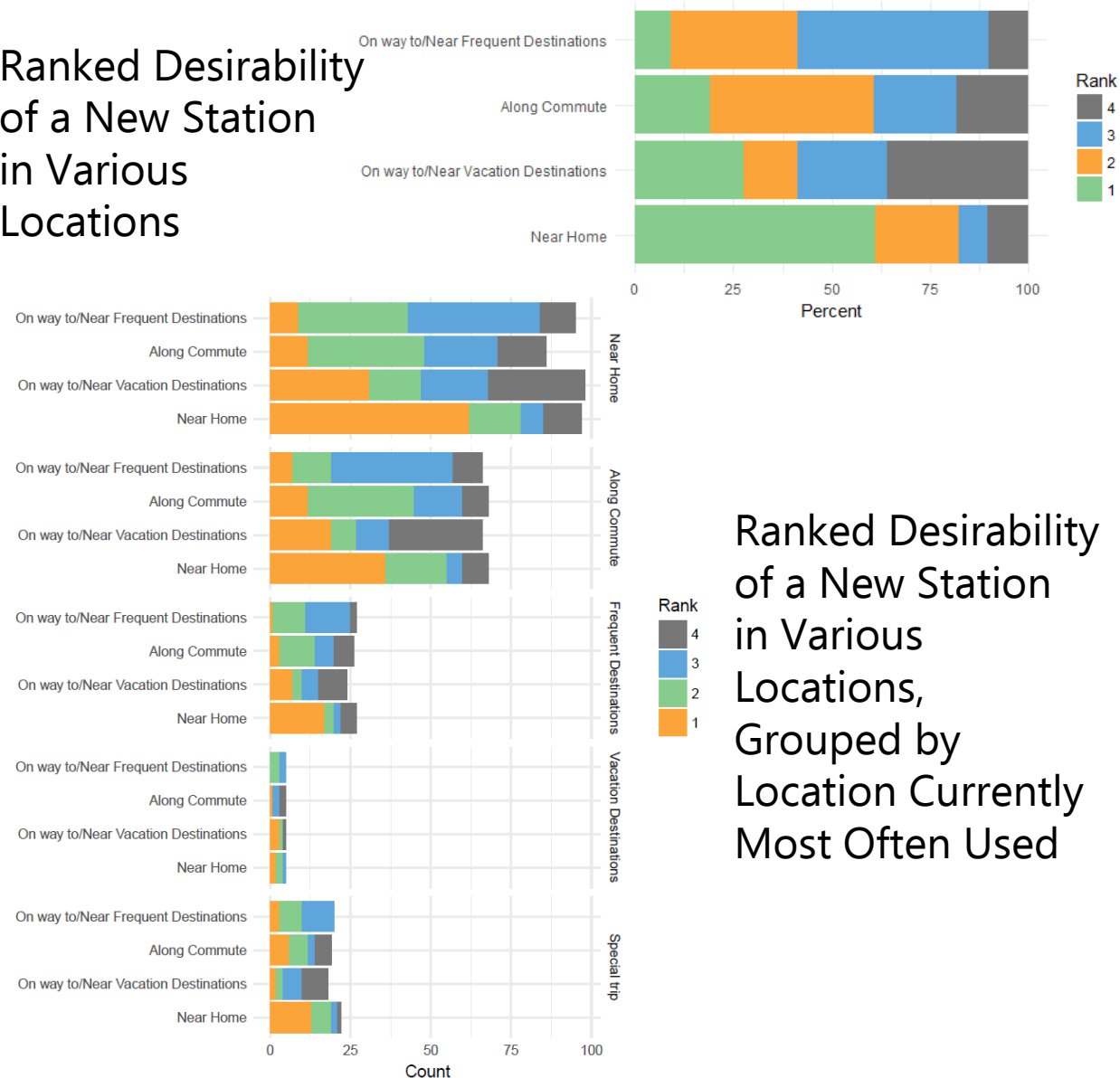
Importance of Additional Station Location to Allow Exclusive Use of FCEV for all Needs



# Desired Station Locations

Additional stations near home are the most desired location overall and (mostly) regardless of the station location drivers currently use most often

## Ranked Desirability of a New Station in Various Locations



# ONLINE VIEWER

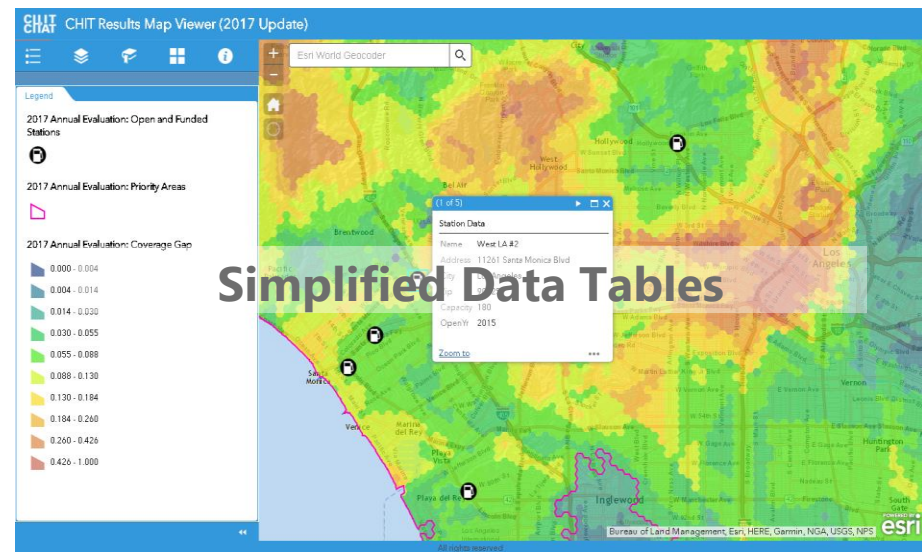
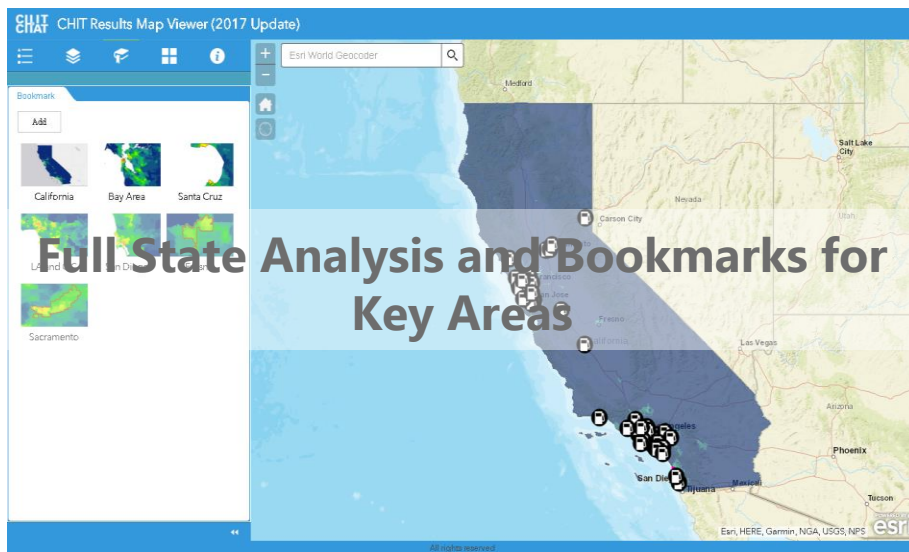
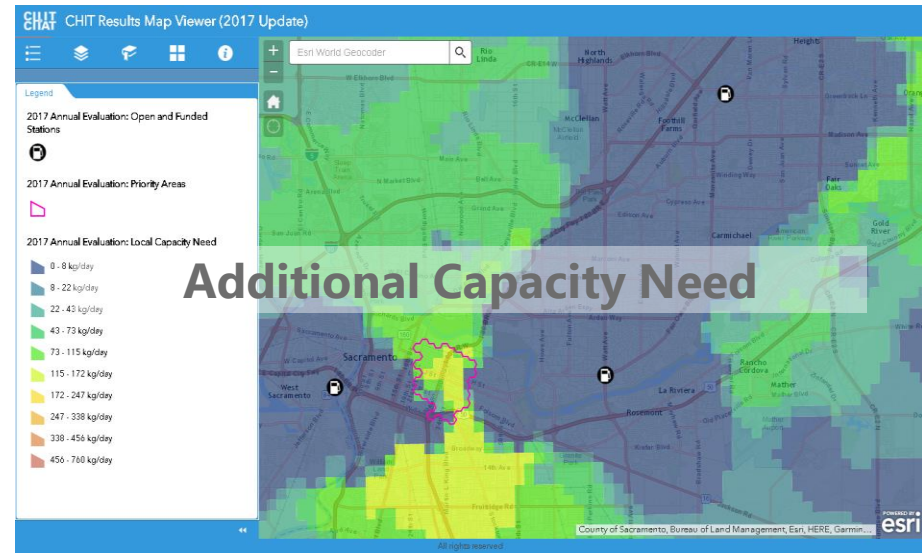
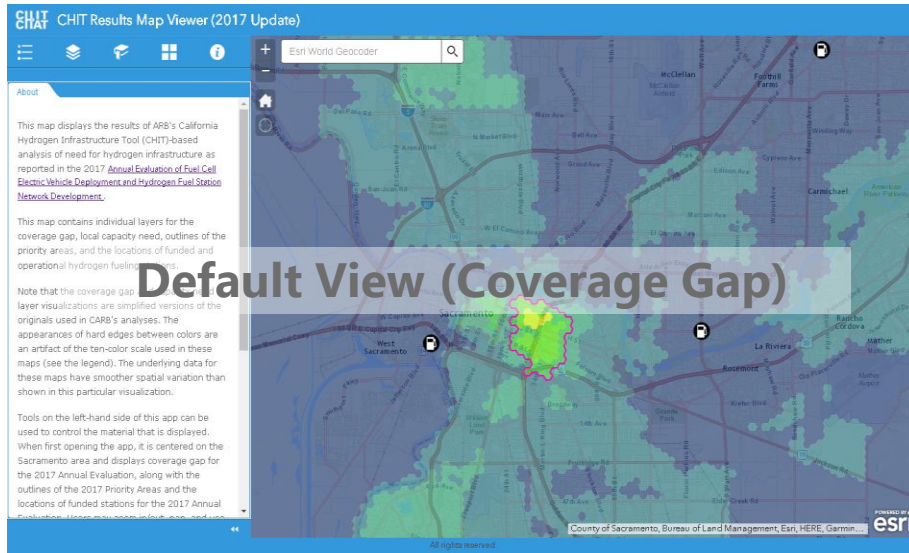
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# Updated Online Viewer for CHIT 2017 Release

- Intended to allow interested parties without access to desktop ArcGIS (since it is not free software) to have access to the results of the CHIT analysis utilized in the 2017 Annual Evaluation
- Link provided on CARB's Hydrogen Fueling Infrastructure Assessments page:  
<https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.htm>
- Previously provided similar map viewer for CHIT 2015 Release results used in 2015 and 2016 Annual Evaluations and updated analysis used for GFO-15-605

# Updated Online Viewer for CHIT 2017 Release



# FUTURE IMPLEMENTATION

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# Ongoing Development Concepts

- Scenario analysis tool of station placement
  - Exploration of “what if” scenarios for numbers/locations of stations assuming various station technology development and vehicle rollout schedules
  - CARB is NOT developing this as a capability to determine specific optimized locations for station placement
  - Any analysis likely to be presented for discussion and aggregated regionally
- Addition of a redundancy factor to increase CHIT coverage gap evaluation tendency to cluster stations
- Implementation of station availability data (such as through SOSS) to scale coverage provided by stations
  - Proprietary station operational data concerns need to be recognized
- Addition of station throughput data (such as through NREL data reporting) as an additional observational demand input
  - Proprietary station operational data concerns need to be recognized

# ACCESS TO CHIT DATA AND TOOLS

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CHIT Desktop Tool available (2017 and 2015 Releases both posted) at:  
<https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.htm>

CHIT 2017 Release Online Map Viewer:

<http://californiaarb.maps.arcgis.com/apps/webappviewer/index.html?id=99be905d3127405e81851fd60b19cda2>

CHIT 2015 Release and GFO-15-605 Online Map Viewer still Available:

<http://californiaarb.maps.arcgis.com/apps/webappviewer/index.html?id=f2bc784715984f3cb2905dbc4a0391b6>

# OPEN DISCUSSION

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For questions or comments, contact:

Andrew Martinez

(916) 322-8449

[andrew.martinez@arb.ca.gov](mailto:andrew.martinez@arb.ca.gov)





# Coverage, Capacity, and Market Viability under GFO-15-605

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**Jane Berner**

Hydrogen Unit

Fuels and Transportation Division

California Energy Commission

November 14, 2017

# Objectives

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- Review the GFO-15-605 evaluation criteria
- Focus on the “Coverage, Capacity, and Market Viability” evaluation criterion
  - California Hydrogen Infrastructure Tool (CHIT) components
  - Non-CHIT components
- Review each component
  - What types of information could have been provided?
  - Comments and questions





## Upcoming Energy Commission Staff Workshops on Hydrogen Station Network Future Approaches

- November 30:  
Hydrogen Refueling Infrastructure  
Alternative Funding Mechanisms
- December 4:  
Hydrogen Refueling Station  
Technical Requirements
- December 14:  
Evaluation Criteria for Hydrogen  
Refueling Station Applications,  
Critical Milestones, and Data  
Collection



# Docket Information

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- <http://www.energy.ca.gov/altfuels/2017-HYD-02/>
- On this site
  - Relevant workshops, notices, and documents
  - Submit e-comments
  - Contact information
  - Subscribe to Alternative Fuels List Serve



# GFO-15-605 Evaluation Criteria

Evaluation Criteria	Possible Points
Qualifications of the Applicant/Project Team	60
Coverage, Capacity, and Market Viability	100
Safety Planning	40
Project Readiness	40
Station Operation and Maintenance	40
Project Budget	25
Financial Plan	15
Hydrogen Refueling Station Performance	60
Economic and Social Benefits	20
Innovation	20
Renewable Hydrogen Content	30
Renewable Hydrogen from Direct Sources	30
Sustainability and Environmental Impacts	20
Total Points	500

# GFO-15-605 Scoring Scale Summary

From GFO-15-605, Table 8

% of Possible Points	Interpretation
0%	Not Responsive
10 – 30%	Minimally Responsive
40 – 60%	Inadequate
70%	Adequate
80%	Good
90%	Excellent
100%	Exceptional



# GFO-15-605 Scoring Scale

% of Possible Points	Interpretation	Explanation of Percentage Points
0%	Not Responsive	Response does not include or fails to address the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
10-30%	Minimally Responsive	Response minimally addresses the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
40-60%	Inadequate	Response addresses the requirements being scored, but there are one or more omissions, flaws, or defects or the requirements are addressed in such a limited way that it results in a low degree of confidence in the proposed solution.
70%	Adequate	Response adequately addresses the requirements being scored. Any omission(s), flaw(s), or defect(s) are inconsequential and acceptable.



From GFO-15-605, Table 8

Continued on next slide

# GFO-15-605 Scoring Scale, Continued

% of Possible Points	Interpretation	Explanation of Percentage Points
80%	Good	Response fully addresses the requirements being scored with a good degree of confidence in the Applicant's response or proposed solution. No identified omission(s), flaw(s), or defect(s). Any identified weaknesses are minimal, inconsequential, and acceptable.
90%	Excellent	Response fully addresses the requirements being scored with a high degree of confidence in the Applicant's response or proposed solution. Applicant offers one or more enhancing features, methods or approaches exceeding basic expectations.
100%	Exceptional	All requirements are addressed with the highest degree of confidence in the Applicant's response or proposed solution. The response exceeds the requirements in providing multiple enhancing features, a creative approach, or an exceptional solution.



From GFO-15-605, Table 8

# Application Content

From GFO-15-605, Section IX (F)(4)(g)

“Applicants should address each Evaluation Criterion in this solicitation (including all sub-bullets under each criterion) providing sufficient, unambiguous detail so that the Energy Commission Evaluation Team will be able to evaluate the application.

Applicants are highly encouraged to use the exact titles from the Evaluation Criteria as the heading for each response.

If an Evaluation Criterion does not apply to the proposed project, Applicants should briefly describe why the criterion does not apply.”





# Coverage, Capacity, and Market Viability Evaluation Criterion

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- CHIT coverage
- CHIT capacity
- Projected vehicle demand
- Redundancy and back-up
- Fleets
- Peak fueling
- Average number of fills
- Proximity to facilities
- Complements existing and planned stations



# Coverage, Capacity, and Market Viability (Main Station Competition)

From GFO-15-605, Table 9

“Applications will be evaluated on the degree to which:

- The proposed station location results in a high CHIT Station Coverage Value.
- The proposed station capacity results in a high CHIT Station Capacity Value.
- The proposed station provides refueling service that meets the hydrogen refueling needs for the projected vehicle demand (light duty vehicle traffic count and patterns).
- The proposed station provides redundancy and back-up in a location needing fueling capacity.”



Continued on next slide

# Coverage, Capacity, and Market Viability (Main Station Competition)

Continued from previous slide

“Applications will be evaluated on the degree to which:

- The proposed station provides refueling service for local fleets, as practicable.
- The proposed station provides refueling service that is available during peak fueling periods for light duty vehicles passing the station (daily, weekly, or during other time periods) and the peak fueling periods for the location do not conflict with timeframes allowed by local ordinances.
- The proposed station meets the needs of a higher average number of fills over a 1- and 12-hour period.”



Continued on next slide

# Coverage, Capacity, and Market Viability (Main Station Competition)

Continued from previous slide

“Applications will be evaluated on the degree to which:

- The proposed station provides refueling service for vehicles tested and deployed at automotive parts assembly, testing, distribution, and demonstration facilities.
- The proposed station’s refueling service complements the coverage and capacity of the network of existing and planned hydrogen refueling stations in Table 1 and any other new stations proposed for funding by the Applicant under this solicitation.”



# First and Second Bullet Points

“The proposed station location results in a high CHIT Station Coverage Value.”

“The proposed station capacity results in a high CHIT Station Capacity Value.”

- Applicants provided these two values in their applications
- CARB confirmed the values with the Energy Commission Evaluation Team
- The Evaluation Team considered the CHIT values qualitatively and independently
- CARB recalculated CHIT values after each station was selected



# Classification of Data

- For transparency and completeness, CHIT results have been provided to the public and GFO applicants with relatively high precision
  - Online Map: Range from 0-1, with precision to 0.001
  - Desktop Tool: Coverage Gap and other data provided with precision to 0.000001
- Significant differences in values do not occur at such high precision.
- CHIT's hot spot analysis, priority area determinations, and visualization in the online map seek to identify meaningful differences in values
- Use of CHIT in the GFO process was similarly informed, using the Natural Breaks method to determine meaningful differences between CHIT values
- Natural Breaks is a statistics-based method that minimizes the total variation within ranges. The effect is to identify groups of statistically similar values. In practice, groups are often separated by gaps in data values.

# Classification of Data

- During scoring rounds for GFO-15-605, the Natural Breaks classification system was used as an information resource by the Evaluation Team when they made qualitative assessments of CHIT values
- The information considered by the team included:
  - Ranges of CHIT values statistically similar to each other
  - The proportion of CHIT values in each range
  - CHIT ranges and proportions evaluated on the basis of all evaluation cells across the state
- This evaluation was repeated after every "CHIT Round"
- CARB and the Energy Commission collaborated closely throughout all CHIT Rounds and evaluations



# Classification of Data

- After every proposed station award was selected, the entire distribution of coverage gap scores, groups, and size of groups were re-evaluated to reflect the changing interpretation of given Location Values
- For example, a Location Value of 0.311 may have been more rare and in a higher-ranked group after 12 rounds of awards than prior to any award selections
- In early rounds, a value of 0.311 may have been statistically similar to all values 0.2-0.4. After several awards, the distribution may have shifted, such that 0.311 was similar to values 0.282-0.333.
- These data were considered each round by all scorers to adjust their interpretation of Location Value scores

# CHIT and Market Viability

From GFO-15-605, Section IV (C)

“The Energy Commission Evaluation Team will score the application using a combination of the CHIT Station Coverage Value, the CHIT Station Capacity Value, and the market viability as part of one Evaluation Criterion ‘Coverage, Capacity, and Market Viability.’

Proposed locations that have low CHIT Station Coverage and CHIT Station Capacity Values, according to CHIT, have the opportunity to document, demonstrate, and bolster the CHIT Station Coverage and CHIT Station Capacity Values with the market viability of a proposed station and potentially be successful under this solicitation in accordance with the Evaluation Criteria.”



## Third Bullet Point

“The proposed station provides refueling service that meets the hydrogen refueling needs for the projected vehicle demand (light duty vehicle traffic count and patterns).”

- Possible responses
  - Fuel cell electric vehicle projections from CARB’s AB 8 Annual Evaluation
  - Proximity and traffic flow to freeways, major streets
  - How serves origins and destinations
  - Consistency with regional transportation plan, general plan, alternative fuel readiness plan
  - Characteristics of local residential area, employment centers
  - Applicant’s own observations about market potential



## Third Bullet Point, Continued

“The proposed station provides refueling service that meets the hydrogen refueling needs for the projected vehicle demand (light duty vehicle traffic count and patterns).”

- Possible responses
  - Information from:
    - » Auto manufacturers or dealerships
    - » Location owner/operator
    - » Local governments
    - » FCEV drivers or prospective drivers



## Fourth Bullet Point

“The proposed station provides redundancy and back-up in a location needing fueling capacity.”

- Possible responses
  - Proximity to the nearest funded stations (open or planned)
  - Usage of those nearest stations
  - Is the proposed station near another station you are proposing?  
How do they support each other?
  - Is the station a redundant system?



## Fifth Bullet Point

“The proposed station provides refueling service for local fleets, as practicable.”

- Possible responses
  - List of identified local fleets and their potential refueling needs
    - Number of FCEVs
    - Estimated date needed
    - Time of day of refueling
  - Fleets are not part of the applicant’s business model
    - Reasons why



## Sixth Bullet Point

“The proposed station provides refueling service that is available during peak fueling periods for light duty vehicles passing the station (daily, weekly, or during other time periods) and the peak fueling periods for the location do not conflict with timeframes allowed by local ordinances.”

- Possible responses
  - How the station meets or exceeds the minimum technical requirement for peak fueling capacity
  - Fuel sales in the local area (gasoline and hydrogen)
  - Hours of operation allowed by the local jurisdiction





## Seventh Bullet Point

“The proposed station meets the needs of a higher average number of fills over a 1- and 12-hour period.”

- Possible responses
  - How the station meets or exceeds the minimum technical requirements for daily fueling capacity and peak fueling capacity
  - Site design features (space to increase capacity)
  - Station design features (multiple fueling positions; compression, storage and dispensing systems)
  - Alignment of station design with anticipated demand



## Eighth Bullet Point

“The proposed station provides refueling service for vehicles tested and deployed at automotive parts assembly, testing, distribution, and demonstration facilities.”

- Possible responses
  - Partnerships the applicant has identified
    - Business agreement(s)
    - How the agreement(s) will enhance station viability
  - These types of facilities are not part of the applicant’s business model
    - Reasons why
    - Other customer bases



## Ninth Bullet Point

“The proposed station’s refueling service complements the coverage and capacity of the network of existing and planned hydrogen refueling stations in Table 1 and any other new stations proposed for funding by the Applicant under this solicitation.”

- Possible responses
  - How the proposed station location responds to the AB 8 reports’ (CARB’s Annual Evaluation or the Joint Report) findings related to coverage and capacity needs of the station network
  - How the proposed station location supports the needs identified through discussions with auto manufacturers, local stakeholders, and based on applicant’s own analyses



# Coverage, Capacity, and Market Viability Sub-Bullets

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- Any comments or questions about them?
- Anything you like or dislike about them?
- In the future
  - How should CHIT be used?
  - What market viability factors should be included or excluded?
  - Why?



Questions  
Comments  
Suggestions



# BACKUP SLIDES

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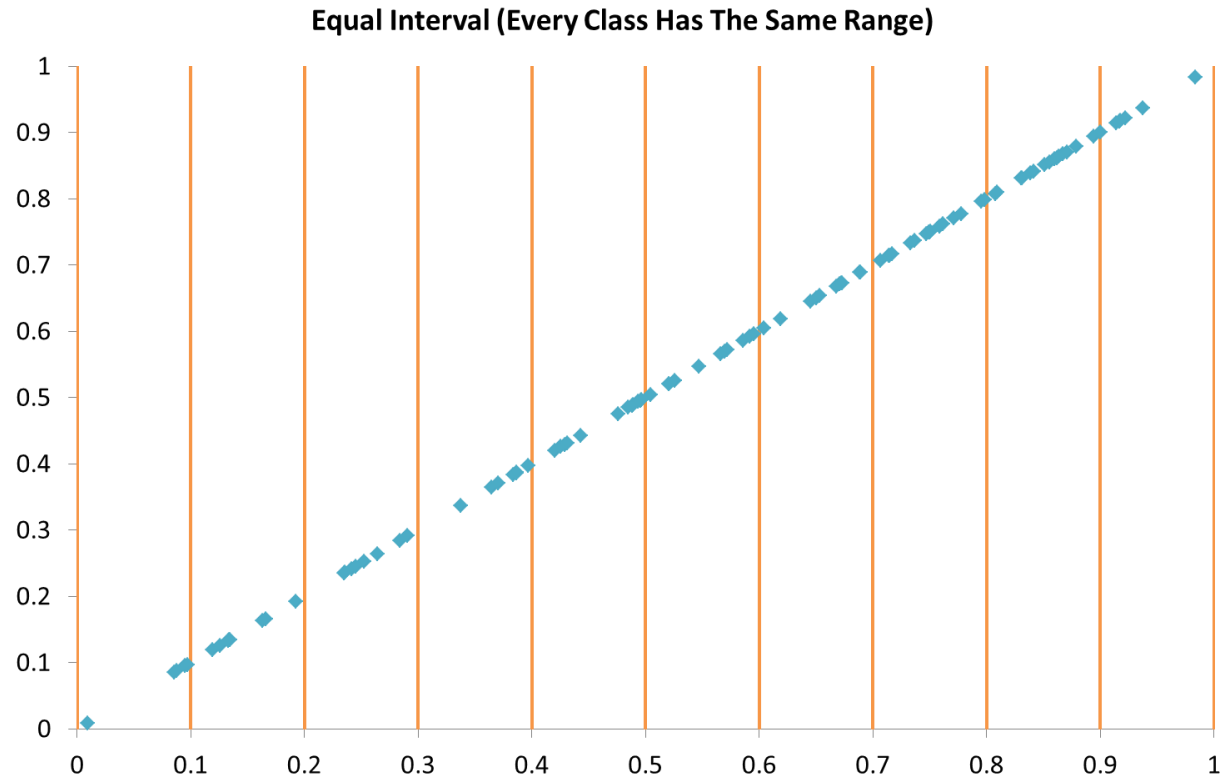
What is Natural Breaks classification?

# Classification of Data

- The following slides provide a walk-through of classification methods and the effect of changing data inputs on determination of classes within a dataset.
- For all slides, plotted data points are randomized values generated in Excel for demonstration purposes. Vertical lines are the max/min values of each class. Only one list of data was created, but to visually spread the data out, all points are plotted with the x and y coordinate equal to the data point value.

# Classes Have Equal Range

This method is conceptually easy to grasp, but does not take into account any information about the distribution of the underlying data. Also notice there is a wide range of number of points in each group.



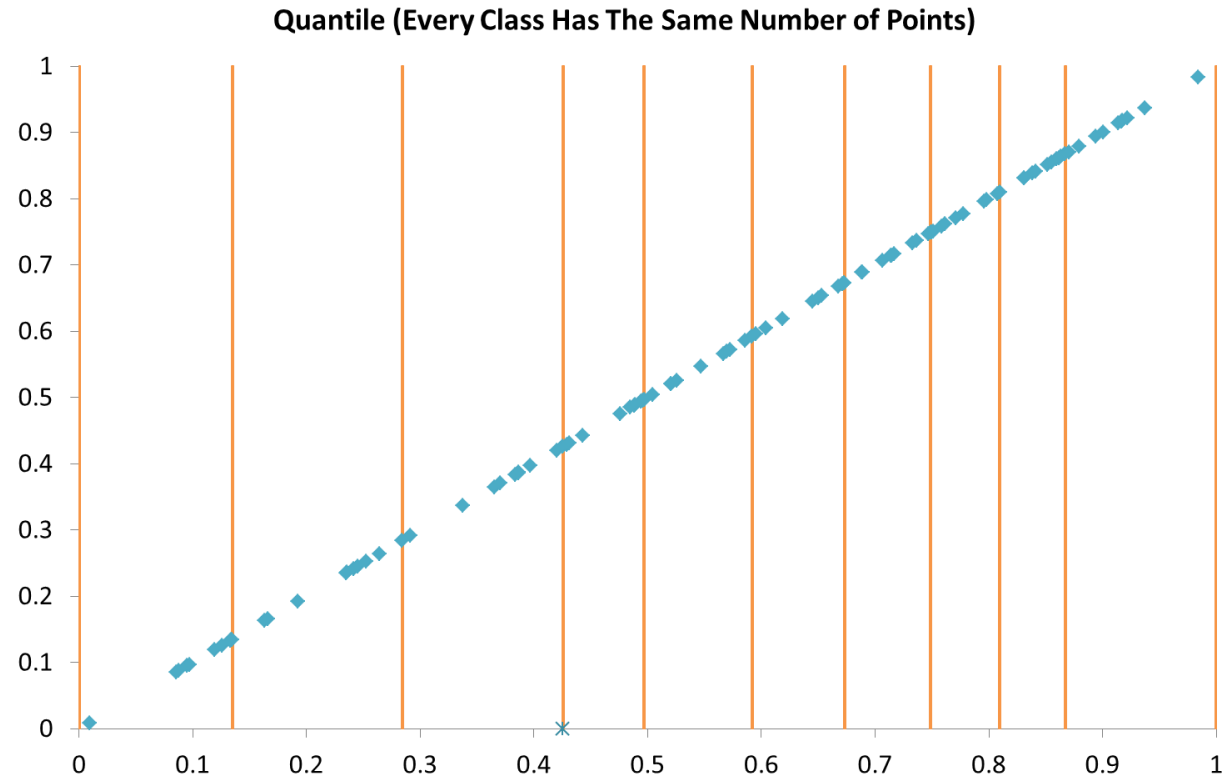
	Count
Group 1	5
Group 2	8
Group 3	8
Group 4	7
Group 5	11

	Count
Group 6	11
Group 7	11
Group 8	16
Group 9	15
Group 10	7



# Classes Have Equal Representation

In this method, classes are defined by limited information from the underlying distribution. For example, there's no guarantee that every point in the top class is significantly greater than every point in the next class down (and in this example, they don't appear to be).



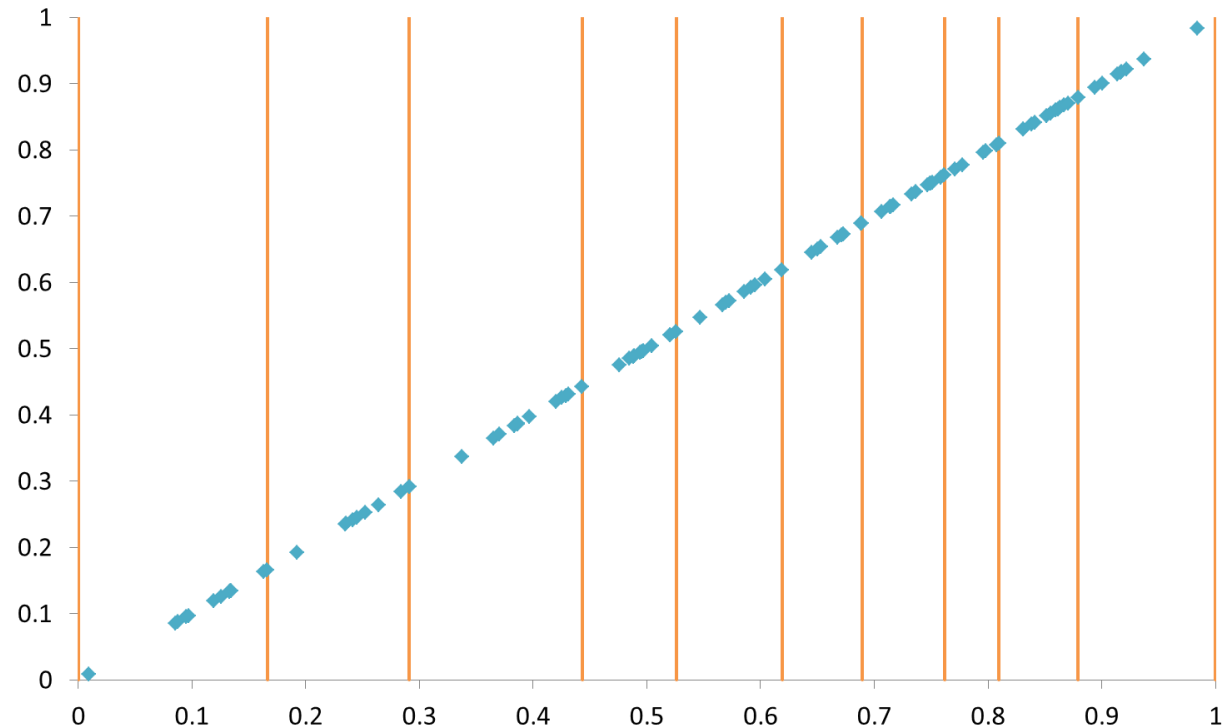
	Count
Group 1	10
Group 2	10
Group 3	10
Group 4	10
Group 5	10

	Count
Group 6	10
Group 7	10
Group 8	10
Group 9	10
Group 10	10

# Natural Breaks

Natural Breaks better aligns the divisions with the “gaps” in the data. It is more informed by the distribution of the underlying data. Data in the top group all do have a separation from the next group down. Additional groups could be implemented (there are noticeable gaps remaining that aren’t also cutoffs), but this is the optimum for 10 classes.

Natural Breaks (Minimized Variation Within Classes)

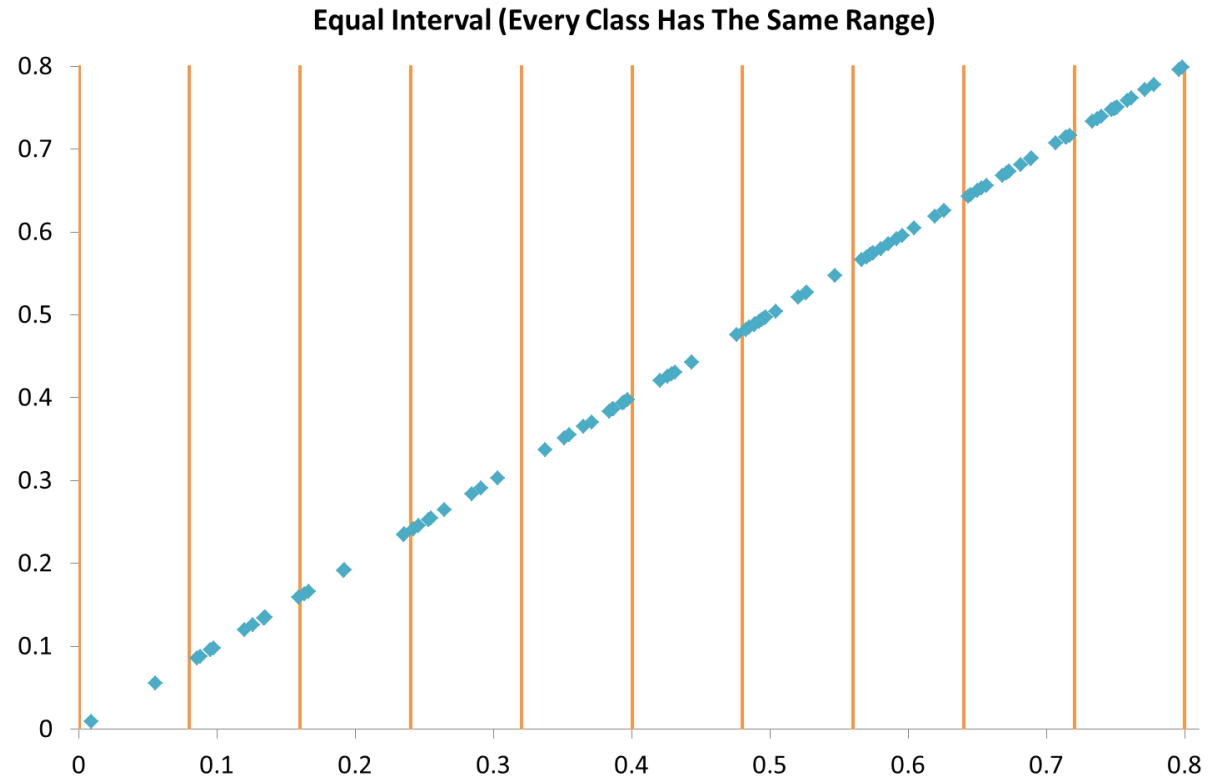


	Count
Group 1	11
Group 2	10
Group 3	12
Group 4	10
Group 5	10

	Count
Group 6	8
Group 7	13
Group 8	6
Group 9	11
Group 10	9

# Equal Ranges Respond to Modifications

To simulate the effect of adding a station, all high values ( $>0.8$ ) have been re-calculated to a new random value with a lower maximum (0.75). After re-calculation, the same observations still hold true for each method.

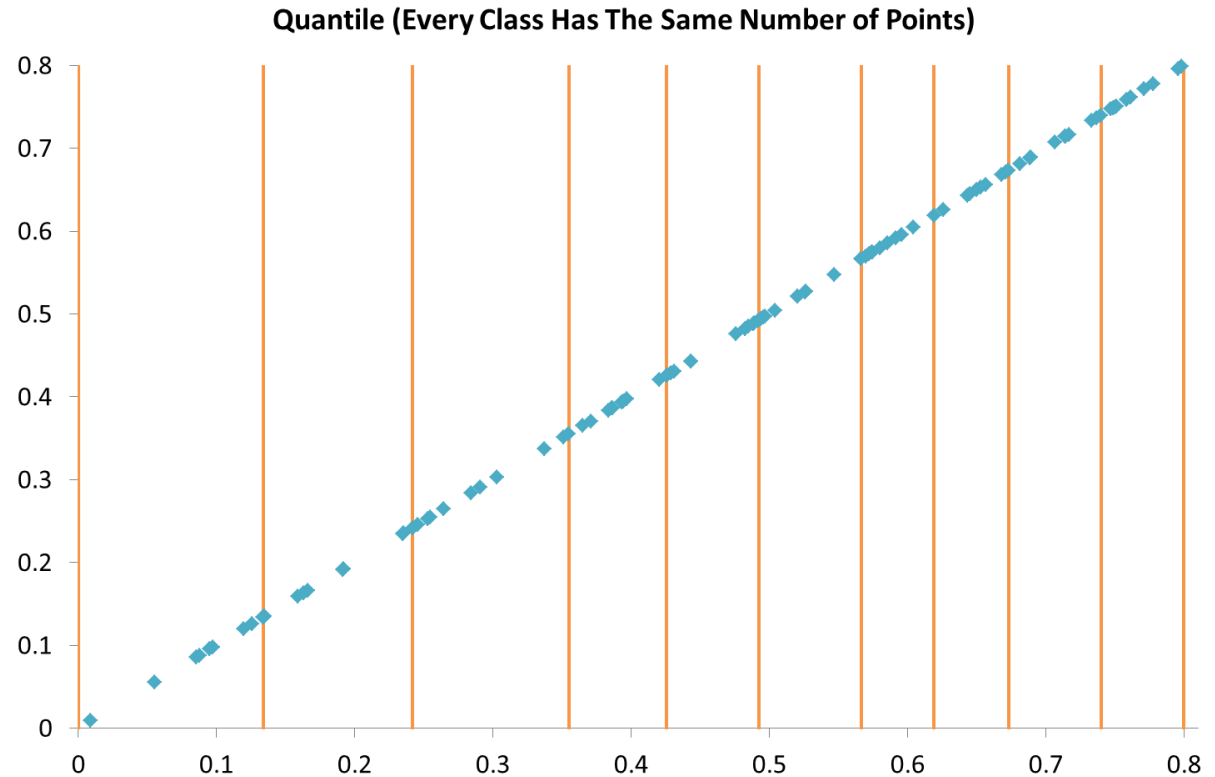


	Count
Group 1	2
Group 2	11
Group 3	6
Group 4	8
Group 5	11

	Count
Group 6	7
Group 7	14
Group 8	12
Group 9	16
Group 10	13

# Equal-Sized Classes Respond to Modifications

To simulate the effect of adding a station, all high values ( $>0.8$ ) have been re-calculated to a new random value with a lower maximum (0.75). After re-calculation, the same observations still hold true for each method.

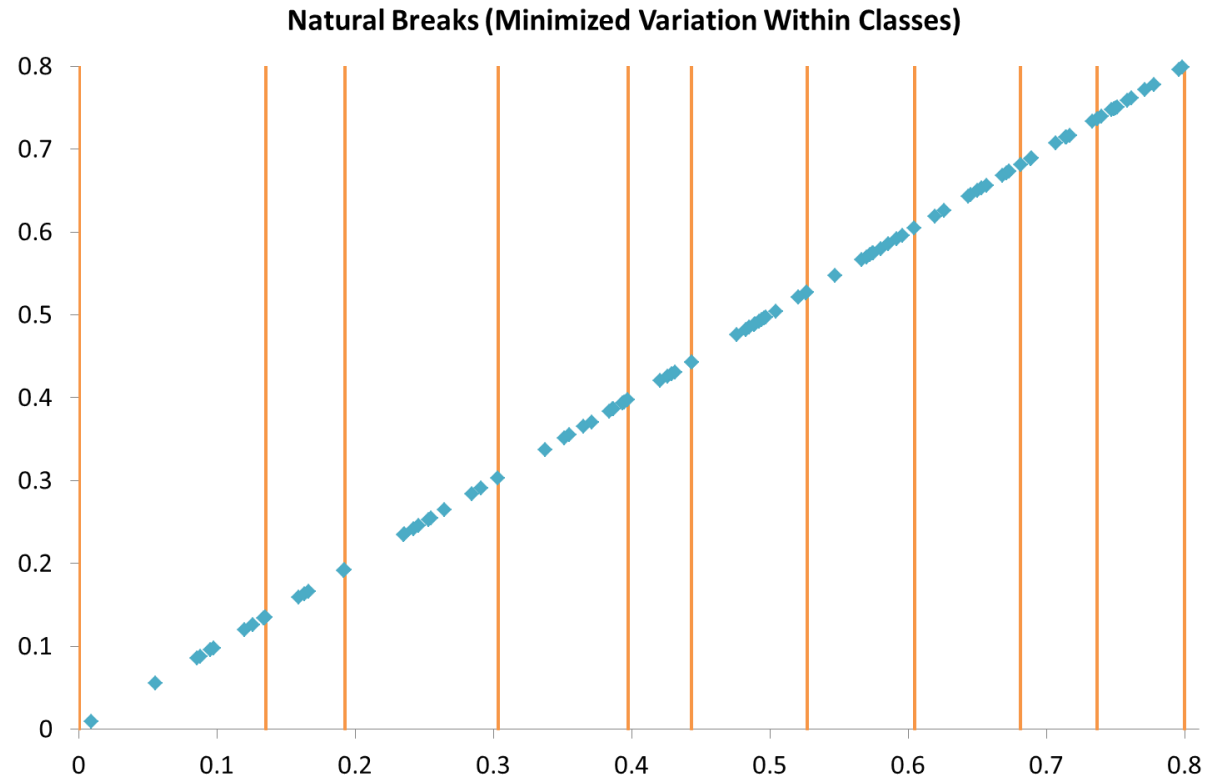


	Count
Group 1	10
Group 2	10
Group 3	10
Group 4	10
Group 5	10

	Count
Group 6	10
Group 7	10
Group 8	10
Group 9	10
Group 10	10

# Natural Breaks Respond to Modification

As before, the best alignment with the “gaps” and breaks in the data is through this method. Also note that the number in each group is less variable than in the equal interval method.



	Count
Group 1	11
Group 2	10
Group 3	12
Group 4	10
Group 5	10

	Count
Group 6	8
Group 7	13
Group 8	6
Group 9	11
Group 10	9

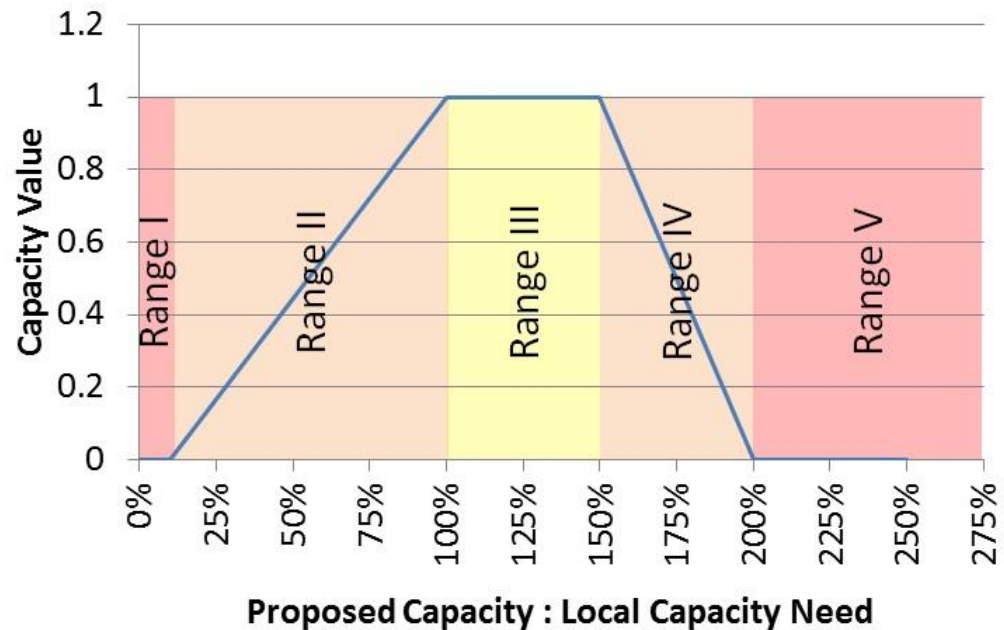
# BACKUP SLIDES

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How was Capacity Value Calculated?

# Capacity Value

Capacity Value was determined similar to Olympic events: the maximum possible value was determined by the local need and the actual value was a percentage of that maximum based on the match between proposed capacity and local need



Range I: Avoid severe under-building

Range II: Growth to maximum score at station capacity meeting exact need

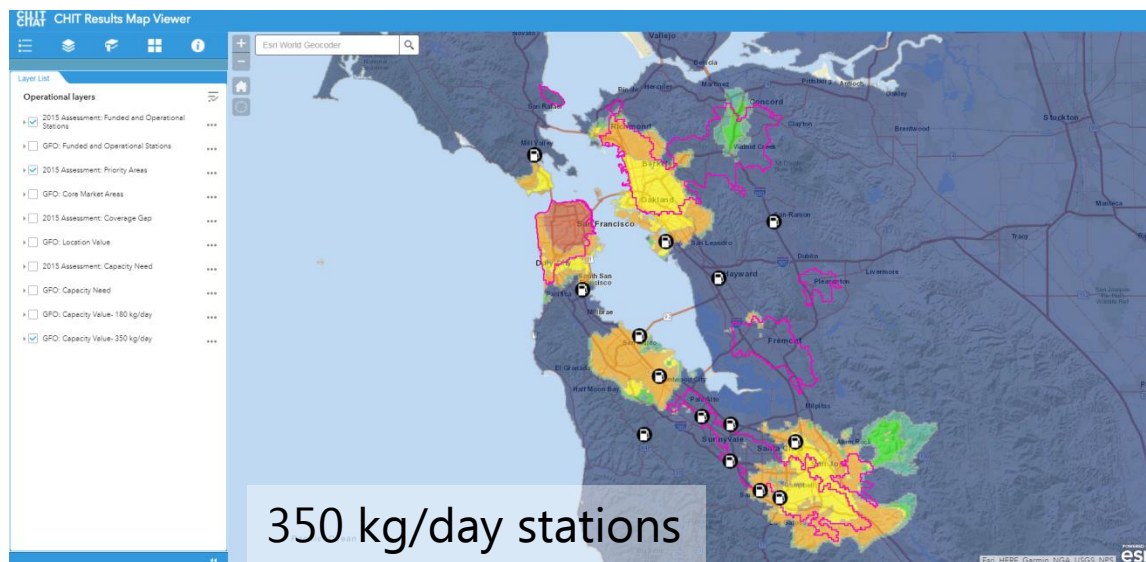
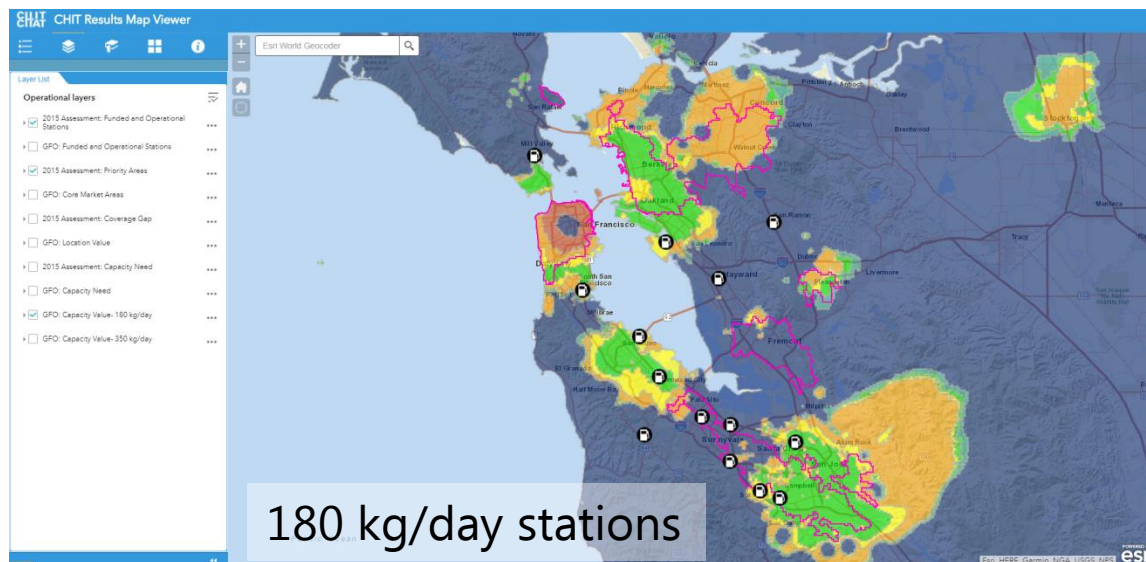
Range III: Buffer to allow reasonable overbuild

Range IV: Decrease in score as overbuild approaches excess

Range V: Avoid severe overbuild

- As with coverage value, capacity value was also determined iteratively in each "CHIT Round" for GFO 15-605

# Sample from GFO 15-605





# Benefits of Method

- Did not disincentive proposals for stations in high-need areas
  - A straight ratio of proposed capacity to local need would have been very difficult to score high in high-need areas like San Francisco (with a local need over 2,000 kg/day) with current technology
- Allows for appropriately-sized stations in lower-need areas to still score high for capacity
- Maintains preference for more appropriately-sized station between two options within the same market
- Avoids incentivizing over-build in low-need markets